Australian Government

Department of Infrastructure and Transport

# TNIP

## Transparent Noise Information Package

# CARBON COUNTER

*Carbon Footprint Analysis and Reporting Tool for Aircraft Operations*

## USER MANUAL v3.0

*June 2012*

# Preface

TNIP Carbon Counter has been developed to enable rapid computations of the carbon footprint of aircraft operations. The Department is faced with ongoing day to day requirements to compute these footprints. The development of strategies for managing aviation's contribution to climate change needs to be underpinned by robust carbon footprinting. Public confidence in action to address climate change is reliant on robust tracking and verification of carbon footprints. Requests for carbon footprint data arising from aircraft operations are regularly received from a range of quarters such as other government departments, research organisations, industry, academics and students.

Many tools for counting the average amount of carbon generated by specified city pair aviation journeys can be found on the internet. However, these commonly give quite divergent results for the same journey. The International Civil Aviation Organization (ICAO) Carbon Calculator is now widely recognised as the accepted tool for providing this city pair information. TNIP Carbon Counter is built on the same computational algorithms as the ICAO Carbon Calculator. While individual city pair carbon information is very useful, in most applications there is a need to aggregate this data across a large number of routes. Accordingly, TNIP Carbon Counter has been set up with the capability to both compute the carbon for average single aircraft operations and to aggregate the average single carbon footprints over a large number of movements.

In keeping with the design philosophy of the other TNIP aircraft noise applications, TNIP Carbon Counter has been set up to be accessible to as wide a group of users as possible. It is a Microsoft Access application that runs on standard personal computers; uses simple aircraft movement datasets; and computes carbon using great circle distance algorithms. Validation against fuel sales data within Australia indicates that the program generates robust carbon footprint information.

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# Part I

# Getting Started

# Chapter 1

# Introduction to TNIP Carbon Counter

The range of demands for carbon footprinting information has significantly expanded over time and capabilities have been progressively added to TNIP Carbon Counter in response to these broadening requirements. In general terms, the program has evolved from a tool which computed carbon footprints for aircraft departures from specified airports (based on notional fuel uplifted) to a network carbon footprinting tool.

In its current guise the program is capable of computing and outputting carbon footprint information for a range of applications – average footprints for city pair journeys and for departures from specified airports; network and regional operations; and aviation travel by corporate employees. The package can produce internal graphical reports or can be used to generate filtered datasets which can be exported for analysis and/or the production of graphics in third party software.

**Important Note**: TNIP Carbon Counter computes footprints using Great Circle Distance and average fuel consumption data. While it gives robust results when computing across a number of flights (see ***Chapter 13***), it is not intended to be used for computing the carbon generated by an individual flight. More sophisticated modelling (requiring inputs such as actual track distance, thrust settings, etc) has to be applied to examine the carbon footprint of individual operations.

## 1.1 The Drivers for Development

Experience in recent years has demonstrated that the carbon footprint of aviation is poorly understood. As a result there has been ongoing spirited public debate at the international level, which is far from resolved, about the impacts of aviation on climate change and on the type of policy responses that are called for. TNIP Carbon Counter is being developed as a tool which enables a user to transparently carbon footprint aircraft operations. Hopefully this will contribute toward global efforts to better understand the climate change challenges faced by the aviation sector and work toward options that are best suited for effectively managing this issue.

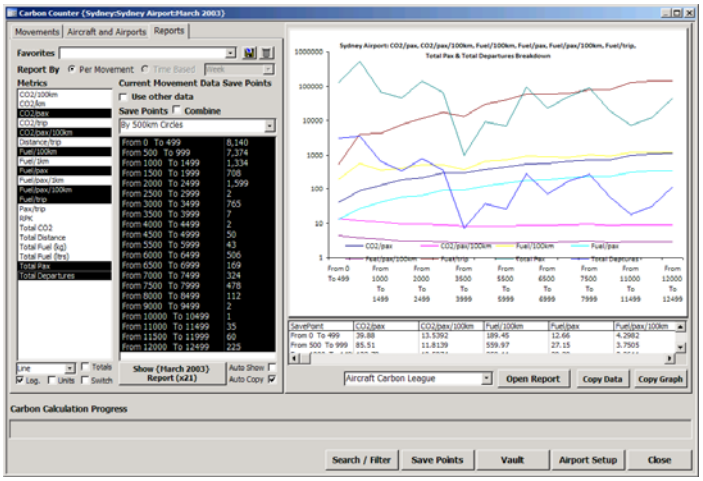



**Figure 1 Example interface**

The development of strategies for managing the emission of greenhouse gases from aviation clearly need to be underpinned by a solid understanding of, and robust numerical data on, the patterns of $CO_2$ emitted by aircraft. At the present time most policy makers only have access to high level fuel use data. For example, in Australia the Department of Resources, Energy and Tourism publishes data on jet fuel sales at the National and State/Territory level (http://www.ret.gov.au/resources/fuels/aps/pages/default.aspx). It also breaks this down into fuel for domestic and international operations. While this is useful, it does not enable either the policy maker or a member of the public to understand the drivers behind the macro fuel use figures – the implications of proposed and/or actual expansions at airports, the introduction of new aircraft types, the introduction of new services and/or routes, changing load factors, changing travel demand patterns, etc.

In the absence of understanding carbon footprints at the disaggregated level there will be a danger that decisions made both by individuals about personal travel, and by government decision makers on long term strategies, may not achieve the optimum outcomes.

## 1.2 Design Concept

TNIP Carbon Counter has been designed in such a way as to facilitate transparency and to assist in building trust in carbon calculations, both for decision makers and members of the public, by allowing the user to drill down into 'the workings'. In line with the TNIP noise applications (http://www.infrastructure.gov.au/aviation/environmental/transparent_noise/tnip.aspx), the aim is to get away from complex black box modelling techniques which effectively entrust knowledge to the hands of a small number of technical cognoscenti. Key features of the design include:

- The model computes fuel use for departures only. This is designed to follow what appears to be becoming standard practice – carbon footprinting on fuel uplifted in order to avoid double counting.
- The use of readily available input data. The model uses the same time-stamped airport/aircraft movement datasets that are used in TNIP noise applications, as well as published airline schedules.
- The fuel burn data which underpins the fuel use calculations is transparent and easily modified. The program comes loaded with the EMEP/CORINAIR fuel use dataset which also underpins the ICAO Carbon Calculator.
- Being a macro tool the results are based on standard averaged data. The user needs to be aware that fuel burn for 'identical' operations can and in most cases will vary, sometimes widely, from flight to flight in the same manner that the noise received on the ground from 'identical' aircraft operations varies.
- The user does not need specialist skills to rapidly interrogate data and produce reports. The user is provided with tools to carry out simple 'what-ifs' and to produce reports exploring the outcomes of different scenarios.

## 1.3 Potential Applications

TNIP Carbon Counter has a number of potential uses. The following list contains examples of potential uses and is not intended to be exhaustive:

- Carbon footprint trend reporting (e.g. State of the Environment reports; regular environment reporting).

- Environmental Impact Assessment – carbon footprinting the outcomes of proposed developments (e.g. new aircraft types, new runways, flight paths, services, etc).
- Community consultation/engagement on airport operations and proposed developments.
- Responding to requests for carbon footprint information from, for example, elected representatives, government agencies, researchers, students and members of the public.
- Briefing decision makers on the carbon implications of proposed actions.
- Policy development – examination of scenarios, what-ifs, etc.
- Analysing trends in efficiency – developing and reporting key performance indicators (KPIs).
- Computing corporate carbon footprints or individual carbon offsetting.
- Examining options for travel at the personal level (e.g. type of aircraft, route, aircraft vs. train, car, etc).
- Carbon footprinting of economic sectors (e.g. tourism, mining, etc).
- Computing the costs per head, and the quantum of funds that would be generated, under varying carbon charging regimes.

# Chapter 2

# Quick Guide

## 2.1 Introduction

This part of the manual aims to provide the user with a quick tour of TNIP Carbon Counter without expanding on the more advanced parts of the program. The full functionality of the Carbon Counter is discussed in detail in subsequent parts of this manual. The program is released with three accompanying sample datasets to enable the user to trial the software to gain a sense of its capabilities.

A sample dataset for one month for Sydney Airport is loaded internally. This is the same demonstration dataset that is made available with the noise versions of TNIP. To demonstrate the network capabilities of the program, a synthetic one year dummy dataset for the Australian network has been included in a demonstration data Vault.

A sample corporate dataset is also included to demonstrate the use of the Carbon Counter for corporate footprinting.

## 2.2 Main Menu

When the program is started the user is presented with the main menu shown below. The first three buttons: Airport, Aircraft, and Advanced Setup are associated with the program setup elements of the software.

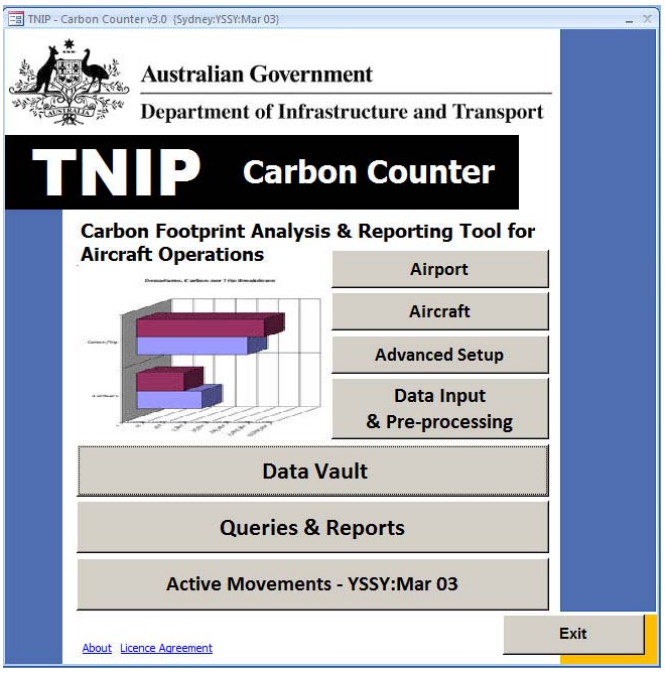



**Figure 2 Main Menu – Sydney vault loaded and March 2003 data movements active**

### Setup

The program is released with sample airport and aircraft setup files already loaded. The user does not need to delve into this part of the program in order to view the output from the program. However, if the user wishes to view details of the airport/s, aircraft types and fuel burn profiles in

the program, then clicking on the first three buttons will enable exploration of the contents of these setup files. The functions underlying these buttons are described in detail in ***Chapter 3*** of this Manual.

The next button [Data Input & Pre-processing] is associated with loading data (see ***Chapter 5***). The [Data Vault] button takes the user to the archive folder structure of the loaded data as discussed in ***Chapter 4***.

**Analysis and Reporting**

The remaining two buttons are for analysing the aircraft movement data and computed carbon and for producing output in the form of graphics or exported data. The [Queries & Reports] button enables the user to examine subsets of the loaded and computed data by applying filtering tools (see ***Chapter 8*** for further details).

The [Active Movements] button allows for detailed carbon footprint analyses to be made for departures from a user selected individual airport and is discussed in ***Chapter 11***.

## 2.3 Queries and Reports

This facility is network based rather than being single airport centric. The interface enables the user to compare various parameters (e.g. number of aircraft operations, fuel usage, carbon emissions, distance travelled, total passengers) for various categories or groupings that have been filtered from the main datasets using the program's filtering tools (see ***Part III***). The **Queries & Reports** window, shown in ***Figure 3***, is accessed by clicking the button with the same name on the Main Menu of the program (***Figure 2***).

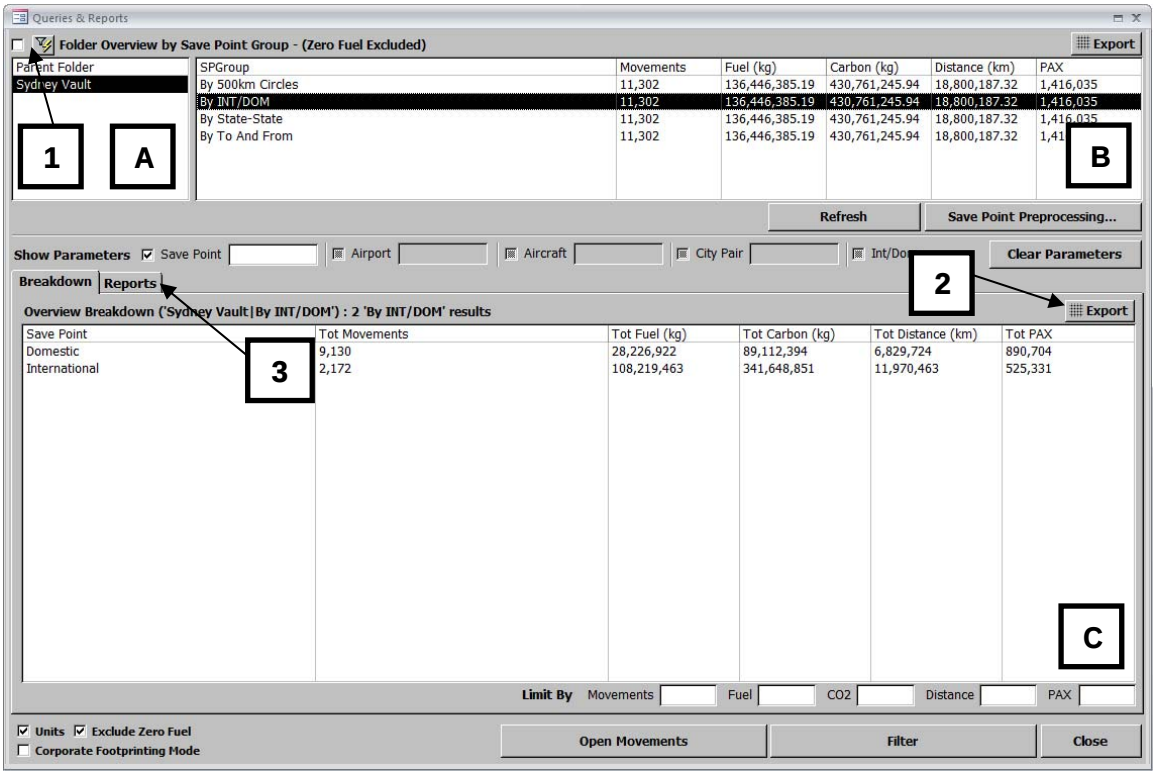

Queries & Reports
Folder Overview by Save Point Group - (Zero Fuel Excluded)
Export
Parent Folder
Sydney Vault
SPGroup | Movements | Fuel (kg) | Carbon (kg) | Distance (km) | PAX
By 500km Circles | 11,302 | 136,446,385.19 | 430,761,245.94 | 18,800,187.32 | 1,416,035
By INT/DOM | 11,302 | 136,446,385.19 | 430,761,245.94 | 18,800,187.32 | 1,416,035
By State-State | 11,302 | 136,446,385.19 | 430,761,245.94 | 18,800,187.32 | 1,416,035
By To And From | 11,302 | 136,446,385.19 | 430,761,245.94 | 18,800,187.32 | 1,41
1
A
B
Refresh
Save Point Preprocessing...
Show Parameters
Save Point
Airport
Aircraft
City Pair
Clear Parameters
Breakdown
Reports
2
Overview Breakdown ('Sydney Vault|By INT/DOM') : 2 'By INT/DOM' results
Export
Save Point | Tot Movements | Tot Fuel (kg) | Tot Carbon (kg) | Tot Distance (km) | Tot PAX
Domestic | 9,130 | 28,226,922 | 89,112,394 | 6,829,724 | 890,704
International | 2,172 | 108,219,463 | 341,648,851 | 11,970,463 | 525,331
3
C
Limit By
Movements
Fuel
CO2
Distance
PAX
Units
Exclude Zero Fuel
Corporate Footprinting Mode
Open Movements
Filter
Close

**Figure 3 Network Carbon Overview - Movements tab**

When movement data is loaded into the program using the **Data Input & Pre-processing** screen (refer ***Chapter 5***), airports and their corresponding movement data are placed inside a user selected folder inside the 'Vault'. The list at **[A]** shows folders in the Vault that have been used to store airport and aircraft movement data. Selecting a folder changes the details in the lists at **[B]** and **[C]** to reflect the information relating to the selected folder.

The user can breakdown aircraft operations into categories or groups using a filtering tool called 'Save Points'. Save Points are, in effect, stored queries that can be used to carry out data disaggregation and filtering (see ***Chapter 7***). The Save Point groups previously created by the user for the movements in the folder selected are shown at **[B]** along with a breakdown of the movement numbers, fuel usage, calculated carbon, distance and passenger statistics for each Save Point group available.

Clicking one of the Save Point group entries in **[B]** shows the computed results for individual Save Points in that grouping in the Overview Breakdown list at **[C]**. The details in this list will also show Save Point breakdown for movement numbers, fuel usage, calculated carbon, distance and passenger statistics.

The example in ***Figure 3*** shows the 'By INT/DOM' Save Point selected in **[B]** which breaks the results down into contributions from the domestic and international sectors as shown in **[C]**. Clicking on the 'Export' button **[2]** copies the results to an Access datasheet which the user can then copy to another application.

Clicking the **Reports** tab at **[3]** enables the user to see the results expressed in additional metrics for the chosen operational grouping (***Figure 4***). This is similar to the **Reports** tab in the **Active Movements** window of ***Figure 7***.

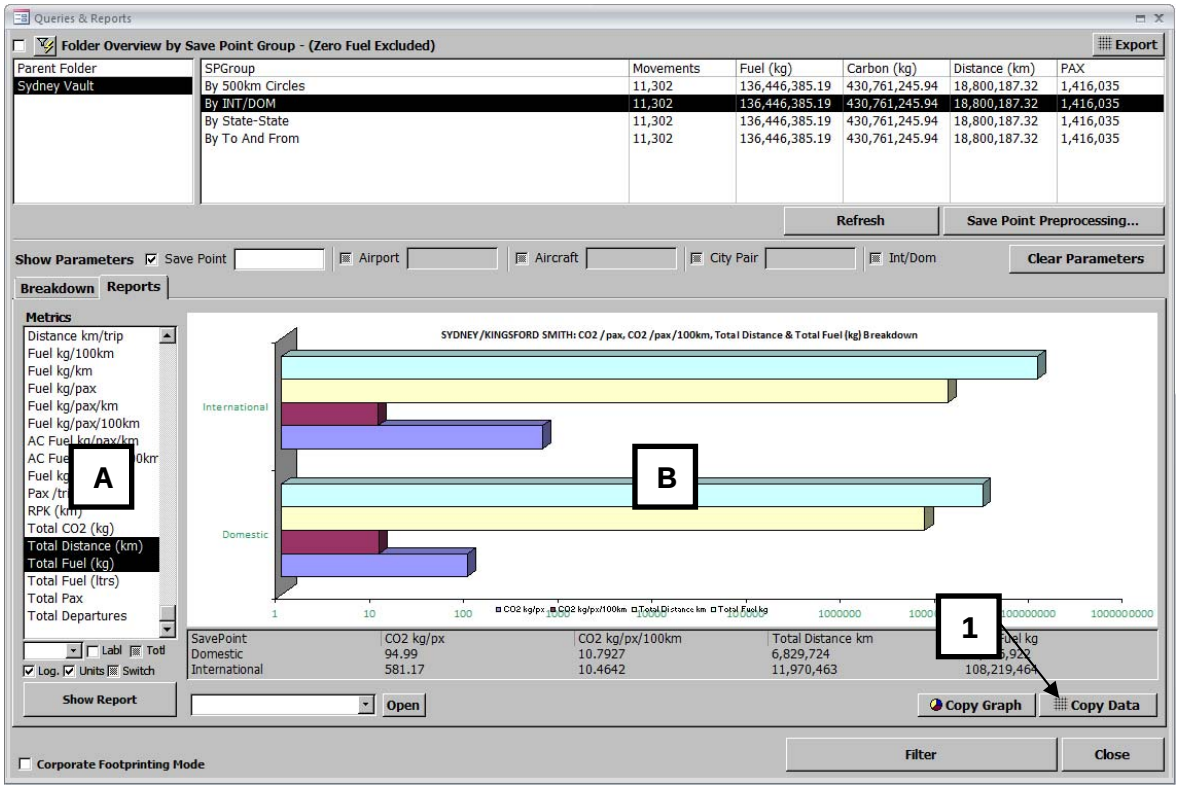



**Figure 4 Network Carbon Overview - Reports tab**

Various metrics can be selected in the listing at **[A]** which are then plotted and listed in **[B]**. The data can be copied to other applications (e.g. Microsoft Access, Excel, etc) by clicking the 'Copy Data' button at **[1]** to facilitate further analysis and the generation of more complex graphics. A more detailed description of the **Queries & Reports** window is discussed ***Chapter 8***.

## 2.4 Active Movements

Detailed single airport based analysis is carried out through the **Active Movements** interface. To open the interface select the Active Movements button on the main menu (the button name will change depending upon whether an airport movement has been made active in the Vault). This brings up the Carbon Counter main interface that initially opens at the **Movements tab [1]** (***Figure 5***).

All movement sets loaded into a vault can be viewed by the **Active Movements** interface; however, to analyse a movement set it must first be made active. For a description on how to activate a movement set refer to ***Subsection 4.5.1***.

This part of the program provides the user with the capability of drilling down into the data for an individual airport.

### 2.4.1 The Movements Tab

The Movements tab **[1]** of the **Active Movements** screen (***Figure 5)*** contains three main areas, show as **[A]**, **[B]** and **[C]** in ***Figure 5***, are discussed below.

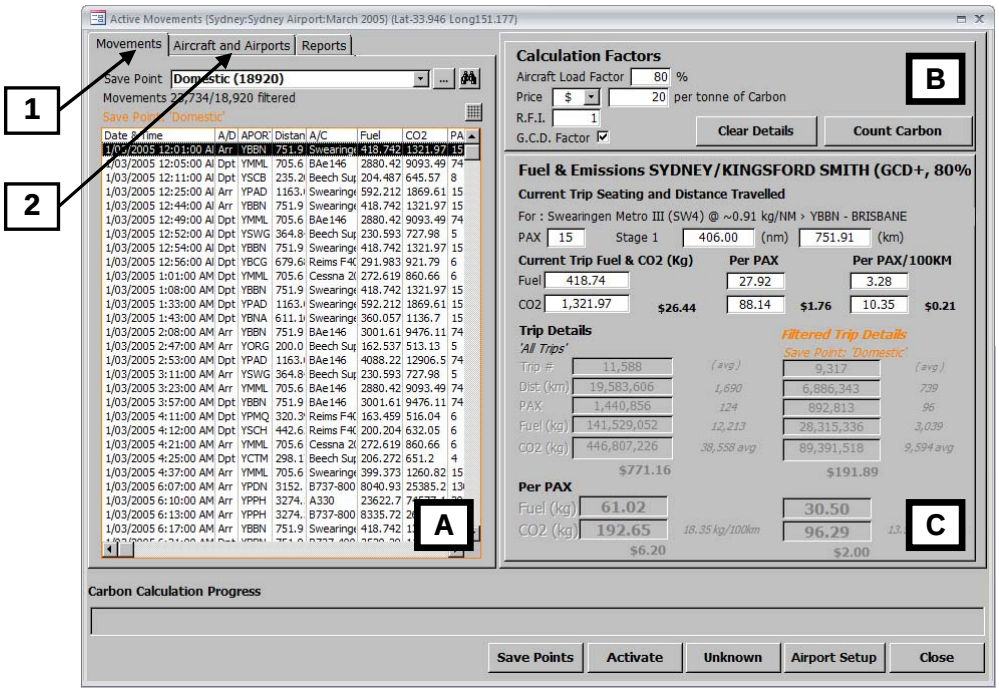



**Figure 5 Carbon Counter Movements tab interface**

- **[A]** The **Data** Section provides a window on the listing of the aircraft movements in the active dataset (see ***Subsection 5.4.2*** for an explanation of 'active dataset').
- **[B]** The **Calculation Factors** Section lets the user enter a value for the load factor, the price of carbon and the RFI (Radiative Forcing Index – a factor to take account of the non-$CO_2$ climate change impacts of aviation). The GCD (Great Circle Distance ) factor can be used to represent the actual average distance flown between two ports which in

practice will be greater than the GCD (e.g. due to the structure of air routes). TNIP Carbon Counter uses the ICAO Carbon Calculator GCD adjustment factor. Further details can be found on page 8 of the ICAO Carbon Emissions Calculator Methodology (http://www2.icao.int/en/carbonoffset/Documents/ICAO%20MethodologyV3.pdf).

- [C] The **Fuel & Emissions Statistics** Section displays a range of information relating to individual and aggregated movements. The individual, aggregated and/or average trip statistics reported relate to various details such as trip distance, fuel burn, movement counts, fuel and carbon emissions for the whole of a trip and also for the average trip and on a per passenger, and on a per passenger per 100 kilometres, basis. Several of the emissions statistics are also given a monetary unit based on the carbon price entered by the user in the **Calculation Factors** Section. These statistics are also affected by the Aircraft Load Factor and the RFI entered.

After setting the calculation factors [B], the user can step through the listing of movements shown in the data window [A]. The fuel/carbon/offset information for the flight highlighted in the data area is shown in the top of the Fuel & Emissions Statistics section in the boxes at [C] which lets the user rapidly learn about the carbon footprint of specific aircraft types on selected routes.

Also present in section [C] are aggregated trip statistics for all trips in the currently active movements (under the title **Trip Details** and **Per PAX**) as well as aggregated trip statistics for a selected Save Point (under the tile **Filtered Trip Distance**).

### 2.4.2 The Aircraft and Airports Tab

Selecting the **Aircraft and Airports** tab ([2] in *Figure 5*) brings up the **Aircraft and Airports** display shown in *Figure 6*. This is similar to the Movements tab except that this tab now shows an aggregated version of the aircraft movements file. This allows the user to step through the dataset at either the aircraft type or airport level (as opposed to the movement by movement level on the Movements tab). Each selection provides fuel/carbon/cost information in the window at [C] as before.

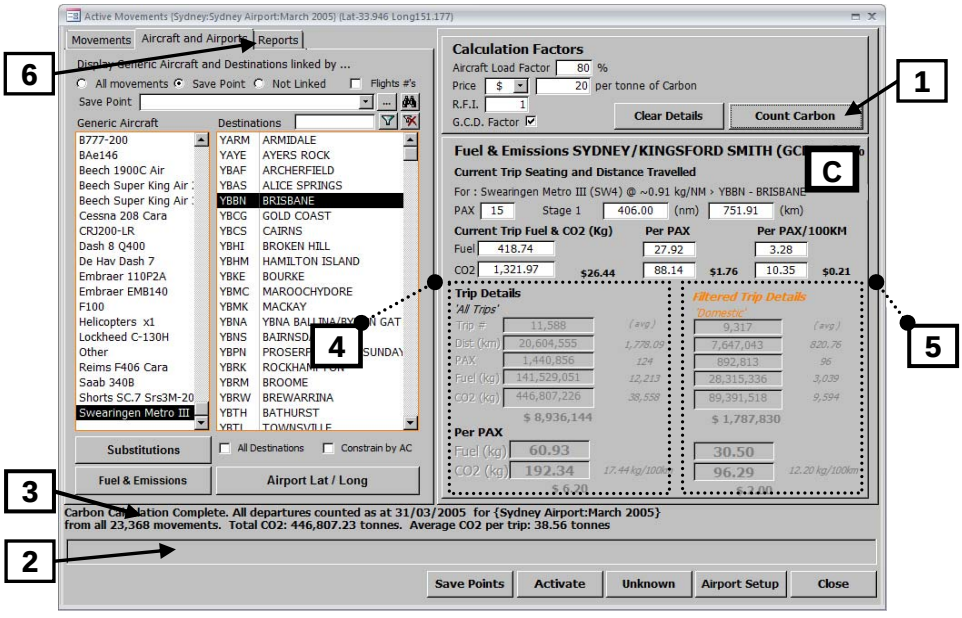



**Figure 6 Aircraft and Airports tab**

### Running a Carbon Count

To this point information has been shown for average individual flights, aircraft types or routes. All the data can be aggregated by selecting the Count Carbon button at **[1]** that is located in the **Calculation Factors** section. When this is selected the program progressively sums up the information about each operation in the aircraft movements file. During this process a progress bar appears at **[2]** and information on the count is progressively updated and shown in the area at **[3]**, in the dotted area at **[4]** and, if a Save Point is selected, at **[5]**. The count can be interrupted at any point by clicking on the 'click to pause' box that appears in the middle of the screen during the counting process. Counting can be restarted by selecting the play button which automatically appears next to the Count Carbon button when counting is interrupted (see ***Section Part IV11.4*** for details).

The information shown in the boxes at **[4]** relates to the whole of the active dataset. Subsets of the main database can be readily selected via the use of Save Points (see ***Section Part III7.2***). When a subset is selected, parallel information for the subset is shown in the box at **[5]**. This is a very useful and powerful tool for generating comparative disaggregated carbon footprint information.

## 2.4.3 The Reports Tab

Selecting the Reports tab (**[6]** in ***Figure 6***) brings up the screen shown in ***Figure 7***.

This screen has four key areas: the metrics list **[A]**, the data selection area **[B]**, the graphics area **[C]** and the data area **[D]**.

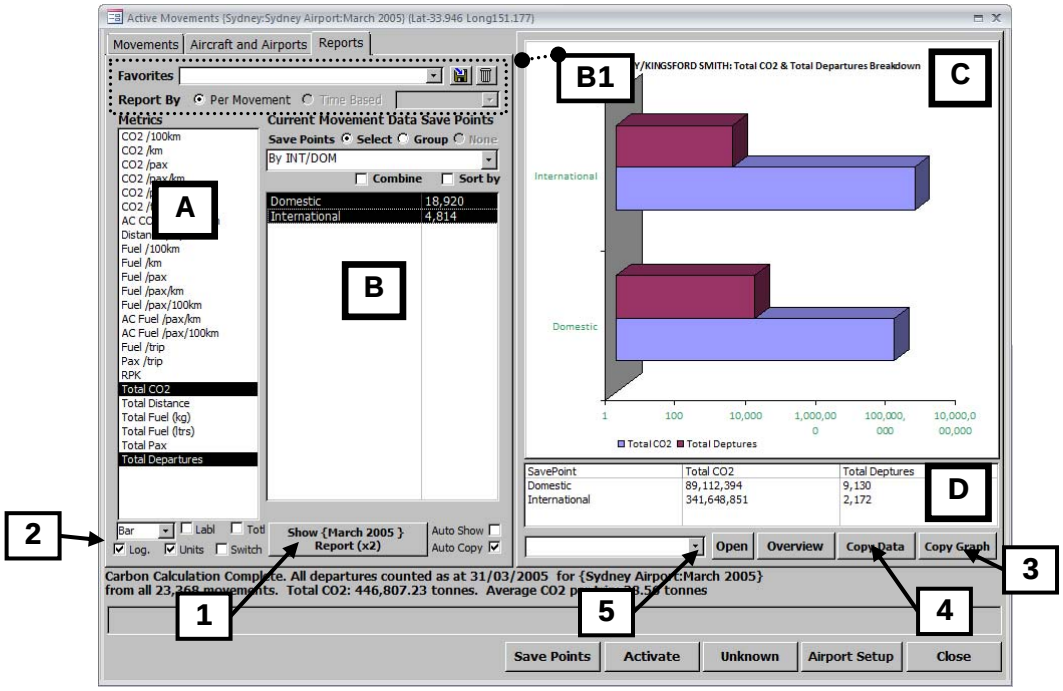



**Figure 7 Reports tab**

- **[A] Metrics List** – this area contains a listing of different metrics for examining the data in the selected dataset or sets. One or any number of the metrics can be selected using the mouse and the control or shift key. When the user initially opens this tab the metrics operate on the active dataset – other datasets can be used, and comparisons between datasets can be made, through the data selection area.

- **[B]** & **[B1] Data Selection Area** – these areas let the user select subsets of the active dataset and select a number of datasets through drop down lists, boxes and radio buttons - this is explained in detail in ***Section Part IV11.5***. When one or more Save Points have been selected from the list in **[B]** computation is initiated by pressing the **Show Report** button at **[1]**. The report is then shown in the graphics area.
- **[C] Graphics Area** – this area gives a graphical display of the results of the computation where the selected metric(s) have been applied to the selected data. The form of the graphic (e.g. pie chart, histogram, etc) can be presented in a number of ways by selecting from the drop down list and boxes at **[2]**. When the program has generated a graphic it may be exported to other programs by selecting the Copy Graph button **[3]** – this places the graphic on the clipboard which then lets the user for example, paste it into a report being generated in Microsoft Word.
- **[D] Report Data Area** – this area contains the data underlying every graphic. This data can be exported to another program by selecting the Copy Data button **[4]** – in a similar manner to the graphics area, this data is placed on the clipboard to facilitate its use in other programs (e.g. Excel).

The program also contains a number of embedded reports which can be generated by selecting from the drop down line list at **[5]**.

## 2.5 Summary

This brief guide has been intended to demonstrate the broad capabilities of the program using sample airport and network datasets. The following parts of this manual provide a detailed description of how the user can set up the program, load data and carry out detailed footprinting analyses.

# Part II

# Data Management

# Chapter 3

# Program Setup

## 3.1 Getting Started

To perform carbon counting a number of key setup steps must be performed. The two key areas are **Airport** and **Aircraft** setup. When these areas have been set up, airport movement data can then be imported and carbon counts can be run.

Airport setup involves, amongst other things, identifying the latitude and longitude of each airport in the movement file. These airport configurations are used to calculate the trip distances and are stored in a single Airport text file.

Aircraft setup, amongst other things, involves the use of two setup files. Rather than providing the fuel burn characteristics for individual aircraft, similar aircraft are grouped together and common fuel burn characteristics are used for each grouping. These aircraft groupings, or substitutions, are the basis of the Aircraft (Substitution) text file and use reference aircraft types with known fuel burn characteristics and are substituted for the actual aircraft used in the movement file. Once the substitutes are defined the fuel burn characteristics for each substitute must be set up. The aircraft substitute fuel burn is stored in the Fuel Burn file.

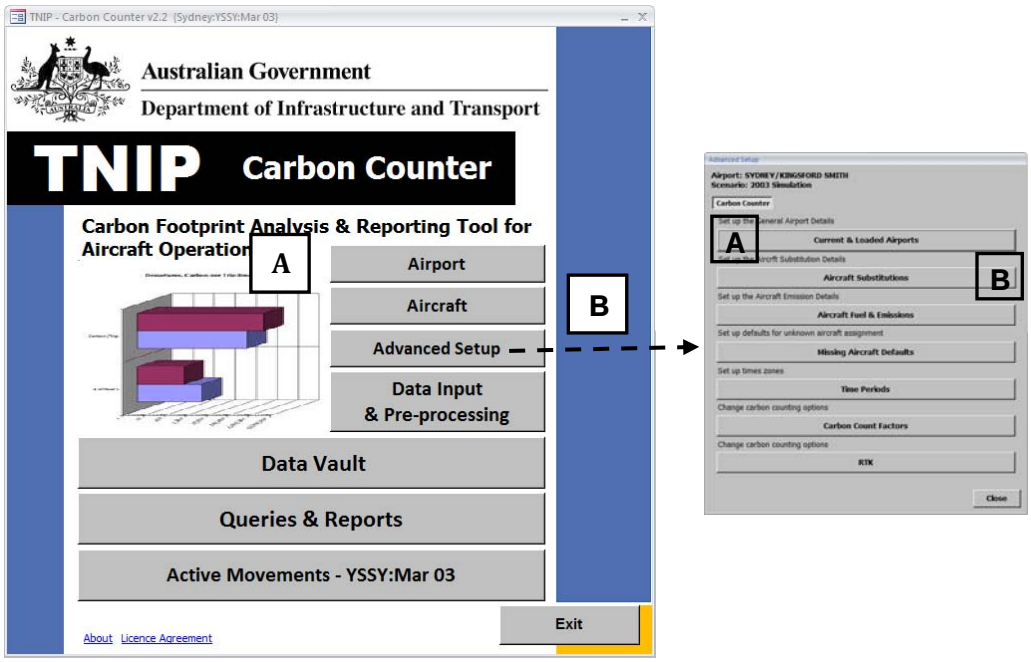



**Figure 8 Main Menu showing Advanced Setup**

For the sake of simplicity the main menu has been designed to provide quick access to the loading and setup of **Airports** **[A]** and **Aircraft** **[B]** via the first two buttons on the main menu: Airport and Aircraft respectively.

It is also possible to access these interfaces by selecting the Advanced Setup button on the main menu and then pressing either of the first two buttons on the **Advanced Setup** menu (*Figure 8*): Current & Loaded Airports **[A]** or Aircraft Substitutions **[B]**.

## 3.2 Airport Set Up

The first part of the carbon calculation process involves the calculation of the distance for each trip. While it is possible to make changes to airports on an individual basis it may be easier, particularly when changing two or more airports, to make these changes directly to the text based Airports file and then load the updated Airports file into the system.

### 3.2.1 Airports File

The Airports file contains information on all the airports currently referred to in the **Origin Airport** and **Destination Airport** fields of a movements file. The format of the Airports file is shown below in ***Figure 9***. Column headings in the first line are optional; however, the order of the data columns is compulsory. While data column names are not necessary they are useful for the user and are recommended.

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| 1 | AirportID | APORT | APORT_LAT | APORT_LONG | APORT_NAME | TIME_ZONE_ | APORT_STATE | APORT_TYPE | APORT_IATA |
| 2 | 1 | AGGH | 09254060S | 160031301E | HONIARA | | INT-SolomonIsland | | |
| 3 | 2 | ANAU | 00325085S | 166550876E | NAURU INTL | | INT-Nauru | | |
| 4 | 3 | AYNZ | 06341138S | 146433447E | NADZAB PNG | | INT-PapuaNewGuinea | | |
| 5 | 4 | AYPY | 09263618S | 147131218E | PORT MORESBY JACKSONS IN | | INT-PapuaNewGuinea | | |
| 6 | 5 | BIKF | 63590600N | 022362000W | KEFLAVIK NAS /ICELAND | | INT-Iceland | | |
| 7 | 6 | BIRK | 64074800N | 021562600W | REYKJAVIK /ICELAND | | INT-Iceland | | |
| 8 | 7 | CYFB | 63452300N | 068332100W | IQALUIT /CANADA | | INT-Canada | | |
| 9 | 8 | CYQX | 48561300N | 054340500W | GANDER INTL /CANADA | | INT-Canada | | |
| 10 | 9 | CYUL | 45280500N | 073442900W | PIERRE ELLIOTT TRUDEAU INTL | | INT-Canada | | |
| 11 | 10 | CYVR | 49114200N | 123105500W | VANCOUVER INTL /CANADA | | INT-Canada | | |
| 12 | 11 | CYYR | 53190900N | 060253300W | GOOSE BAY /CANADA | | INT-Canada | | |
| 13 | 12 | DAAG | 36412765N | 003125547E | HOUARI BOUMEDIENE | | INT-Algeria | | |
| 14 | 13 | DAUH | 31402270N | 006082560E | OUED IRARA | | INT-Algeria | | |
| 15 | 14 | DNMM | 06343853N | 003191616E | LAGOS MURTALA MUHAMMED | | INT-Nigeria | | |
| 16 | 15 | DTMB | 35452900N | 010451700E | HABIB BOURGUIBA INTL | | INT-Tunisia | | |
| 17 | 16 | EBAW | 51112438N | 004274646E | DEURNE | | INT-Belgium | | |
| 18 | 17 | EBBR | 50540500N | 004290400E | BRUSSELS NATL | | INT-Belgium | | |
| 19 | 18 | EBCI | 50273311N | 004271374E | BRUSSELS SOUTH | | INT-Belgium | | |
| 20 | 19 | EBLG | 50381470N | 005263560E | LIEGE | | INT-Belgium | | |
| 21 | 20 | EBOS | 51115600N | 002514400E | OOSTENDE | | INT-Belgium | | |
| 22 | 21 | EDDB | 52224800N | 013312100E | SCHONEFELD | | INT-Germany | | |
| 23 | 22 | EDDC | 51075796N | 013460178E | DRESDEN | | INT-Germany | | |
| 24 | 23 | EDDF | 500200N | 083414E | Frankfurt | | INT-Germany | Asphalt | |
| 25 | 24 | EDDG | 52080471N | 007410539E | MUNSTER OSNABRUCK | | INT-Germany | | |
| 26 | 25 | EDDH | 53374940N | 009591762E | HAMBURG | | INT-Germany | | |
| 27 | 26 | EDDI | 52282289N | 013241420E | TEMPELHOF | | INT-Germany | | |
| 28 | 27 | EDDK | 50515730N | 007083388E | KOLN BONN | | INT-Germany | | |
| 29 | 28 | EDDL | 51172203N | 006460039E | DUSSELDORF | | INT-Germany | | |
| 30 | 29 | EDDM | 48211362N | 011470991E | MUNCHEN | | INT-Germany | | |
| 31 | 30 | EDDN | 49295512N | 011044118E | NURNBERG | | INT-Germany | | |
| 32 | 31 | EDDT | 52333487N | 013171576E | TEGEL | | INT-Germany | | |
| 33 | 32 | EDDV | 52273980N | 009410628E | HANNOVER | | INT-Germany | | |
| 34 | 33 | EDDW | 53025100N | 008471200E | BREMEN | | INT-Germany | | |

**Figure 9 Sample Airports file**

- **Column A**: Shows a sequential ID for the airport. This will not be used at load time and is a number generated by the system when airports are exported.
- **Column B**: Lists the ICAO airport codes (4 characters) which appear in the aircraft movement data file.
- **Columns C & D**: Respectively these two columns show the latitude and longitude of each of the airports in degrees (DD), minutes (MM), seconds (SS), milliseconds (optional) and direction [Dir] and is in the format of DDMMSS[Dir] with a single letter for the direction [Dir] as either N/S or W/E.
- **Column E**: Shows the airport name and may be up to 50 characters in length.
- **Column F**: Is for assigning the airports to various time zones. This information is currently not utilised in the program and can be left blank.
- **Column G**: Assigns the airports to any geographical allocation of the user's choice. For example, the user may wish to categorise the airports according to regional jurisdictions (e.g. States, Provinces, etc), and individual countries or geopolitical regions (e.g. North

Asia, South East Asia, etc). Choosing 'Save Points' (explained in Chapter 7) with 'State' in the name will organise the results into the 'State' groupings defined in this column.

- **Column H**: Records the runway type of the airport (e.g. asphalt, concrete, dirt, etc).
- **Column I**: The IATA code for the airport. If a movement file to be entered uses IATA airport codes this information is used to translate them to ICAO codes.

The program uses the information in this file to compute the great circle distance between the origin and destination airports for each aircraft movement loaded from a movements file.

### 3.2.2 General Airport Details

To load an Airports file or edit or view the individual setup for a specific airport select the Airport button on the main menu to bring up the interface in ***Figure 10***.

While it is not possible to load Airports files directly from this screen, this can be achieved by selecting the Loaded Airports button at the bottom of the screen and using the subsequent interface to load a file. By default the current airport will be displayed and is dependent upon the currently active movement set.

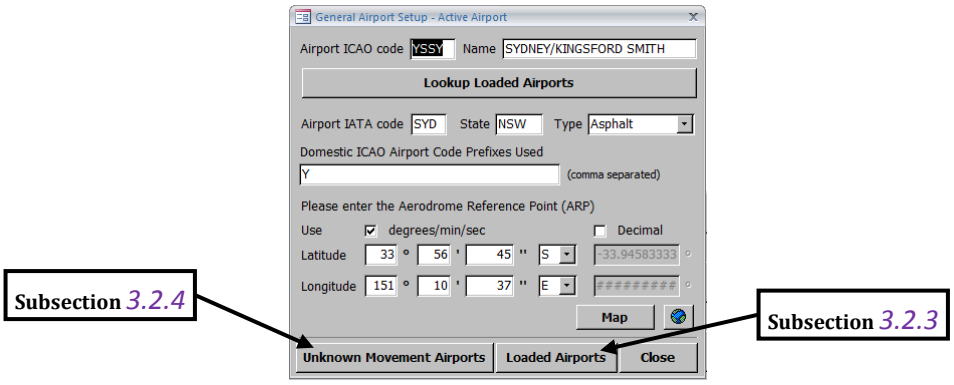

General Airport Setup - Active Airport
Airport ICAO code YSSY Name SYDNEY/KINGSFORD SMITH
Lookup Loaded Airports
Airport IATA code SYD State NSW Type Asphalt
Domestic ICAO Airport Code Prefixes Used
Y
(comma separated)
Please enter the Aerodrome Reference Point (ARP)
Use degrees/min/sec Decimal
Latitude 33 ° 56 ' 45 " S -33.94583333
Longitude 151 ° 10 ' 37 " E #########
Map
Unknown Movement Airports
Loaded Airports
Close
Subsection 3.2.4
Subsection 3.2.3

**Figure 10 Edit Airport Setup interface**

The **General Airport Setup** screen asks the user to enter the name of the current airport, its ICAO code, the Airport IATA code, the state and runway type of the airport and Aerodrome Reference Point (ARP) in latitude and longitude. The user can also input the ICAO code for one or a number of countries that the program then treats as domestic airports. Doing this enables the program to differentiate between domestic and international operations when counting carbon and enables international and domestic Save Point creation and searching.

The ARP information is needed in order for the program to calculate the distance, and hence, fuel use and $CO_2$ generated by each movement.

The user may work in decimal notation. The program calculates the latitude and/or longitude in the format DDMMSS[Dir] for Latitude and DDDMMSS[Dir] for Longitude. DD & DDD = Degrees, MM = Minutes, SS = Seconds and [Dir] = 1 character representation of the direction; Latitude = N(orth) or S(outh); Longitude = E(ast) or W(est).

### 3.2.3 Currently Loaded Airports & File Loading

Selecting the Loaded Airports button on the **Edit Airport Setup** screen (***Figure 9***) provides the user with the ability to examine and edit the currently loaded airport details. From this screen it is also possible to load details from an existing Airports file.

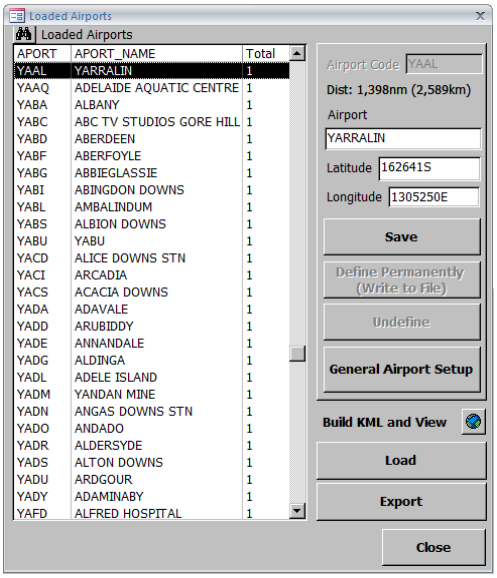



**Figure 11 Loaded Airports interface**

### Edit Existing Details

There are two methods for editing the details for an airport. To quickly change the airport name or its latitude and/or longitude via the **Loaded Airports** interface (***Figure 11***) first select the desired airport from the list, modify the appropriate fields and then press the Save button.

Alternatively, highlight the airport to be changed and then press the General Airport Setup button to edit the airport details via the **General Airport Details** screen.

### Load Airports Files

To load an Airports file click the Load button and, from the **Data File Setup** interface (***Figure 12***) click the button at the top of the interface. Navigate to the file to be loaded and then press the **Open** button.

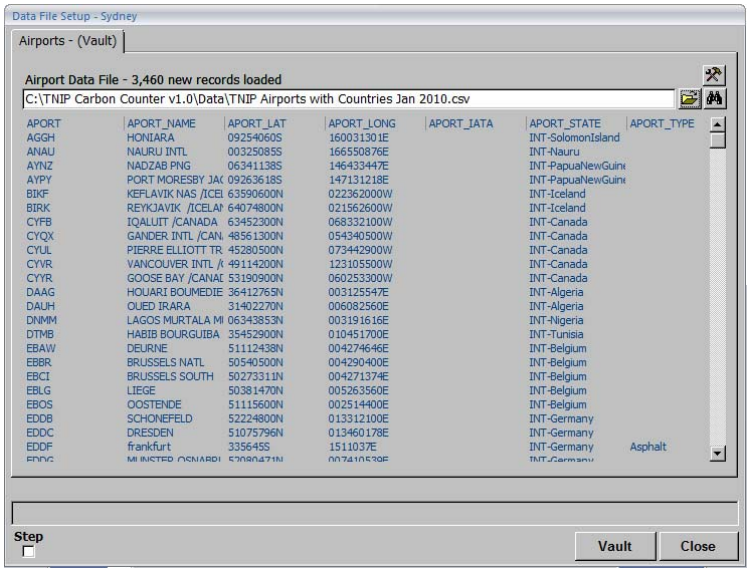

Data File Setup - Sydney
Airports - (Vault)
Airport Data File - 3,460 new records loaded
C:\TNIP Carbon Counter v1.0\Data\TNIP Airports with Countries Jan 2010.csv
APORT APORT_NAME APORT_LAT APORT_LONG APORT_IATA APORT_STATE APORT_TYPE
AGGH HONIARA 09254060S 160031301E INT-SolomonIsland
ANAU NAURU INTL 00325085S 166550876E INT-Nauru
AYNZ NADZAB PNG 06341138S 146433447E INT-PapuaNewGuin
AYPY PORT MORESBY JA( 09263618S 147131218E INT-PapuaNewGuin
BIKF KEFLAVIK NAS /ICEI 63590600N 022362000W INT-Iceland
BIRK REYKJAVIK /ICELAI 64074800N 021562600W INT-Iceland
CYFB IQALUIT /CANADA 63452300N 068332100W INT-Canada
CYQX GANDER INTL /CAN 48561300N 054340500W INT-Canada
CYUL PIERRE ELLIOTT TR 45280500N 073442900W INT-Canada
CYVR VANCOUVER INTL /( 49114200N 123105500W INT-Canada
CYYR GOOSE BAY /CANAI 53190900N 060253300W INT-Canada
DAAG HOUARI BOUMEDIE 36412765N 003125547E INT-Algeria
DAUH OUED IRARA 31402270N 006082560E INT-Algeria
DNMM LAGOS MURTALA MI 06343853N 003191616E INT-Nigeria
DTMB HABIB BOURGUIBA 35452900N 010451700E INT-Tunisia
EBAW DEURNE 51112438N 004274646E INT-Belgium
EBBR BRUSSELS NATL 50540500N 004290400E INT-Belgium
EBCI BRUSSELS SOUTH 50273311N 004271374E INT-Belgium
EBLG LIEGE 50381470N 005263560E INT-Belgium
EBOS OOSTENDE 51115600N 002514400E INT-Belgium
EDDB SCHONEFELD 52224800N 013312100E INT-Germany
EDDC DRESDEN 51075796N 013460178E INT-Germany
EDDF frankfurt 335645S 1511037E INT-Germany Asphalt
Step
Vault
Close

**Figure 12 Airport Data File Setup interface**

On loading an Airports file, if any airports in the currently loaded movements have not been defined the user will be prompted with details of the undefined airports and given the option to fix them before continuing.

The last step in loading the Airports file is the updating of the 'Individual' airport details stored in the Vault. The last prompt allows these airports stored in the Vault to be updated with the contents of the Airports file or left unmodified by not updating the 'Individual' Vault airport details.

For large Vaults this process may take a while and if it is known that no airports in the Vault differ from the airports file this step can be avoided. However, in general, it is best to select 'Yes' to this prompt to ensure vault consistency unless there is a specific reason not to.

**Exporting Airports Files**

It is also possible to have the Carbon Counter generate an Airports file from the currently loaded airports. This is particularly useful when changes are about to be made to the loaded airports and a backup is required. If the current Airports file is missing, the export facility provides an excellent means of providing a replacement file.

To export the current airports simply click the Export button located underneath the Load button in *Figure 11*.

### 3.2.4 Undefined Airports

Selecting the Unknown Movement Airports button on the **General Airport Setup** screen (*Figure 9*) generates the **Undefined Airports** screen that is similar to the **Loaded Airports** screen. The **Undefined Airports** screen (*Figure 13*) enables the user to set up airports that are contained in loaded movements but the program integrity checks have revealed as undefined in the loaded airports.

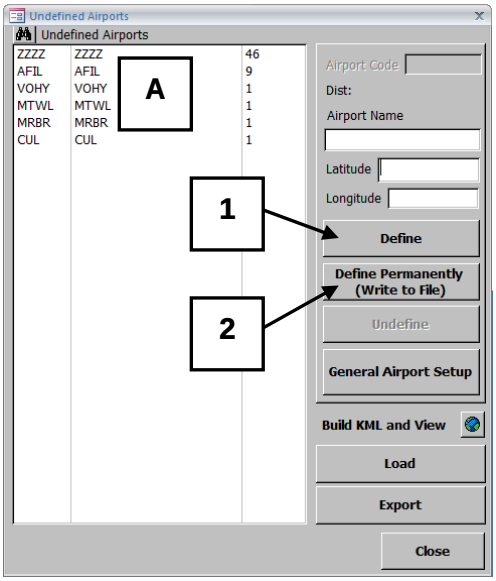



**Figure 13 Undefined Airports interface**

The box on the left **[A]** shows the airports in the loaded movements file that are not contained in the Airports file. The user can add these undefined airports to the Airports file by using the cursor to select one or more of these airports, enter the airport name(s), latitude and longitude, and then select the **Define Permanently** button Define Permanently (Write to File) at **[2]**. Alternatively, the airport can be defined for the currently loaded data by selecting the Define button at **[1]**.

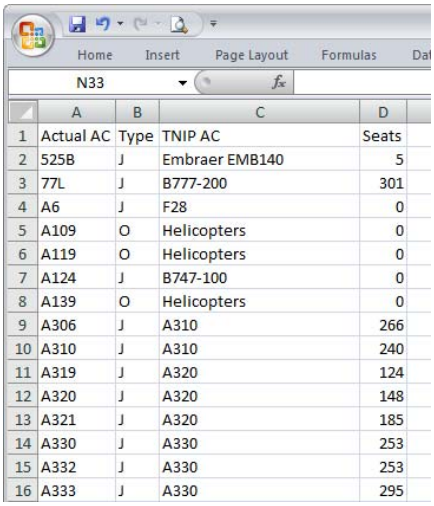
## 3.3 Aircraft Set Up

This section provides the core information that enables the program to compute the fuel burn for each individual operation.

### 3.3.1 Aircraft (Substitute) File

The format of this file is shown in the adjacent example. While it is not necessary to have field names in the first line of this file, it is important to have the four columns of data in the correct order. The four fields include:

- **Column A**: contains an aircraft type code (maximum six characters) that is used to compare against the aircraft type in the aircraft movements file.
- **Column B**: contains a single character which represents one of three aircraft types – 'J' for jets, 'P' for non-jets and 'O' for others (usually helicopters or other unidentified aircraft).
- **Column C**: contains the CORINAIR substitute aircraft code that is one of the aircraft types in the Fuel Burn file discussed in the next Section.
- **Column D**: contains the number of seats for each aircraft type.




| | A | B | C | D |
|---|---|---|---|---|
| 1 | Actual AC | Type | TNIP AC | Seats |
| 2 | 525B | J | Embraer EMB140 | 5 |
| 3 | 77L | J | B777-200 | 301 |
| 4 | A6 | J | F28 | 0 |
| 5 | A109 | O | Helicopters | 0 |
| 6 | A119 | O | Helicopters | 0 |
| 7 | A124 | J | B747-100 | 0 |
| 8 | A139 | O | Helicopters | 0 |
| 9 | A306 | J | A310 | 266 |
| 10 | A310 | J | A310 | 240 |
| 11 | A319 | J | A320 | 124 |
| 12 | A320 | J | A320 | 148 |
| 13 | A321 | J | A320 | 185 |
| 14 | A330 | J | A330 | 253 |
| 15 | A332 | J | A330 | 253 |
| 16 | A333 | J | A330 | 295 |

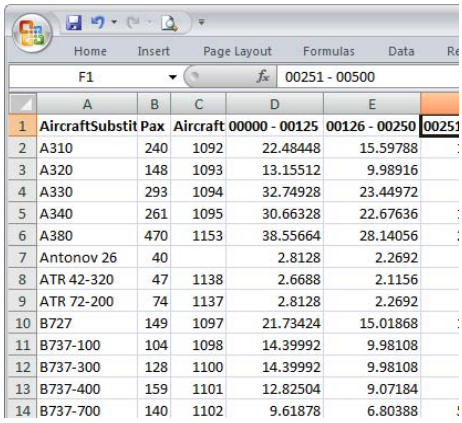
**Figure 14 Aircraft (Substitution) File**

The program uses the data in the aircraft file to differentiate between jet and non-jet aircraft when generating filtered datasets, for setting up auto substitutions and in determining the number of seats for computing statistics on a per passenger basis.

While it is may be easier to make aircraft substitutions changes via the **Aircraft Substitutions** interface seen in ***Figure 16*** it is possible to make these modifications in the Aircraft (Substitute) file and reload the file.

### 3.3.2 Fuel Burn File

The Fuel Burn file seen in ***Figure 15*** is used by the program for setting up the fuel burn characteristics of the various CORINAIR aircraft in Column C of the Aircraft (Substitutions) file (see ***Figure 14***). The Fuel Burn file can be set up and edited using the **En-route Fuel Burn** interface (***Figure 19***) discussed later in this Part. The program also comes with a sample Fuel Burn file.



| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | AircraftSubstit | Pax | Aircraft | 00000 - 00125 | 00126 - 00250 |
| 2 | A310 | 240 | 1092 | 22.48448 | 15.59788 |
| 3 | A320 | 148 | 1093 | 13.15512 | 9.98916 |
| 4 | A330 | 293 | 1094 | 32.74928 | 23.44972 |
| 5 | A340 | 261 | 1095 | 30.66328 | 22.67636 |
| 6 | A380 | 470 | 1153 | 38.55664 | 28.14056 |
| 7 | Antonov 26 | 40 | | 2.8128 | 2.2692 |
| 8 | ATR 42-320 | 47 | 1138 | 2.6688 | 2.1156 |
| 9 | ATR 72-200 | 74 | 1137 | 2.8128 | 2.2692 |
| 10 | B727 | 149 | 1097 | 21.73424 | 15.01868 |
| 11 | B737-100 | 104 | 1098 | 14.39992 | 9.98108 |
| 12 | B737-300 | 128 | 1100 | 14.39992 | 9.98108 |
| 13 | B737-400 | 159 | 1101 | 12.82504 | 9.07184 |
| 14 | B737-700 | 140 | 1102 | 9.61878 | 6.80388 |

**Figure 15 Fuel Burn File**

When editing fuel burn it may be easier to edit the fuel burn text file directly and then reload the file rather than using the interface, particularly when the entries for two or more aircraft

The file may consist of up to 20 or more fields. While an absolute a minimum of four columns are required multiple fuel burn columns are highly desirable. The loaded fuel burn uses 16 columns:

- **Column A**: **AircraftSubstitute**: the name of the CORINAIR substitute.
- **Column B**: **PAX**: the number of seats for each aircraft type.
- **Column C**: **AircraftSubstituteID**: the internal ID for the aircraft substitute.
- **Column D onwards**: *Fuel Burn (kg/nm)*

Each column covers a **minimum** and **maximum** distance which are used to compute fuel burn based on the gate-to-gate trip distance.

The data item in each column represents fuel burn **per nautical mile** at the column's **maximum** distance. When the actual trip distance falls between a column's **minimum** and **maximum** value a straight line interpolation is made between that column's value and that of the previous column.

Column names have three parts:

| Part 1 | Part 2 | Part 3 |
|---|---|---|
| **minimum** (nm - 5 digits) | - | **maximum** (nm - 5 digits) |

Example Fields: *00000 - 00125, 000126 - 00250, 00251 - 00500, 00501 - 01000*

Note the following: There is no space required before or after the hyphen. The range (or band) of each column does not have to be the same for all columns. Each distance range must be unique - a distance cannot fall under more than one column heading.

While the Aircraft (Substitute) file can be given any name the Fuel Burn file must be called **FB.CSV** and must be located in the same directory as the Aircraft (Substitute) file. When an Aircraft (Substitute) file is loaded, the program automatically looks for the **FB.CSV** file.

### 3.3.3 Currently Loaded Aircraft Substitutions and File Loading

The Aircraft button on the **Main Menu** brings up the **Aircraft Substitutions** interface at ***Figure 16*** which can be used to view and edit the current aircraft substitutions; automatically reset the current substitutions as defined in the Aircraft (Substitute) file; or open the **Enroute Fuel Burn** interface (***Figure 19***).

Additionally, this interface can be used to load the two aircraft setup files. To import both the aircraft (substitution) file and the Fuel Burn file use the Load button. The current substitutions and fuel burn can be exported using the Export button.

### Edit Existing Aircraft Substitution Details

To edit an aircraft substitution the user selects an aircraft type in the 'Generic Aircraft Group' list **[1]** and then, if appropriate, selects an aircraft type or types from the 'Available Aircraft' list **[2]** and adds this as a substituted aircraft by use of the > Use button at **[3]**. The list of aircraft substitutes linked to the highlighted generic aircraft is shown in the box on the right. Aircraft can be removed from this list by using the < Remove button **[4]**.

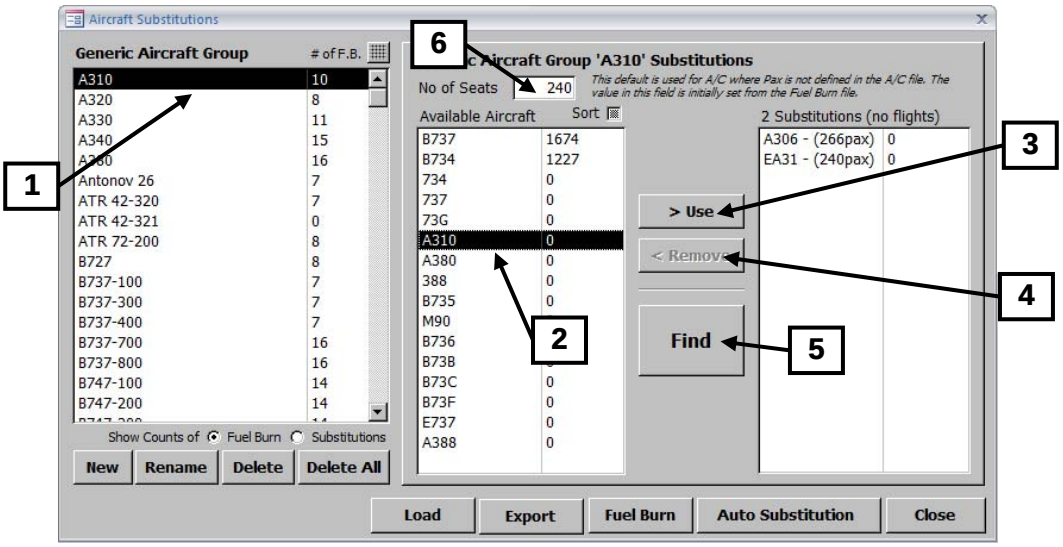



**Figure 16 Aircraft Substitutions interface**

When a new aircraft type is brought into service, such as the B737-800, and none of the existing aircraft types in the CORINAIR dataset can be realistically used as a substitute, the user may create a new substitute group by clicking the New button and entering the name of the new group. Groups can also be renamed via this interface with the Rename button. When deleting a group, substitution information for the group will also be deleted and all aircraft involved in the deleted group will become available in the 'Available Aircraft' list.

### Finding and Adding Aircraft

If an aircraft is to be substituted, however, the particular aircraft was not in the loaded Aircraft file and does not exist in the currently loaded movements it is still possible to add this unlisted aircraft. Select the group in the 'Generic Aircraft' list and then click the button at **[5]** situated between the **Available Aircraft** list on the left and **Substituted Aircraft** list on the right. Follow the prompts to either find an aircraft or, if cannot be found, add it to the substitutes list.

Find

### No of Seats

When carbon is counted the number of seats assigned to an aircraft is taken from the aircraft file. When an aircraft in the aircraft file does not have the number of seats defined the value in the field at **[6]** will be used.

The number of seats defined in the field at **[6]** is initially supplied by the Fuel Burn file. It can be manually overridden, however, every time a fuel burn file is loaded this value will be reset to the value in the Fuel Burn file that is loaded.

### Import Aircraft (Substitute) and Fuel Burn Files

To load both the Aircraft (Substitute) file and the Fuel Burn file open the **Aircraft Substitutions** interface (***Figure 16***), click the Load button to display the **Data File Setup** interface (***Figure 17***) and then click the button at the top right of this interface.

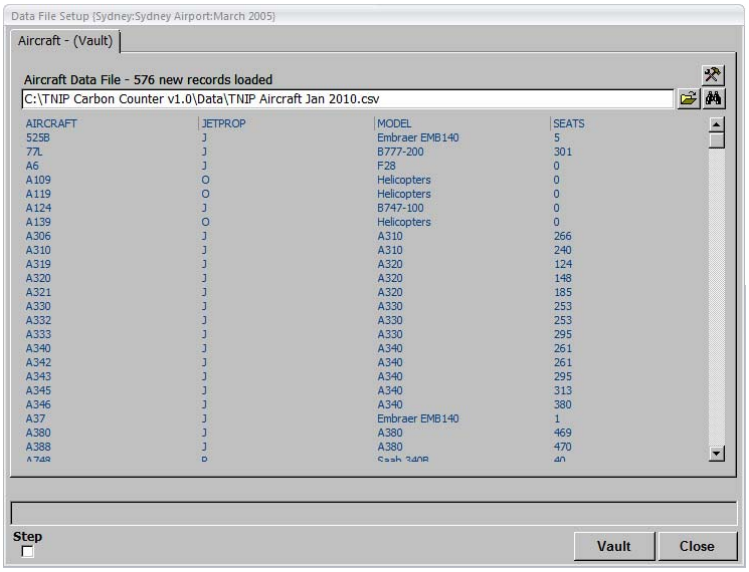

Data File Setup (Sydney:Sydney Airport:March 2005)
Aircraft - (Vault)
Aircraft Data File - 576 new records loaded
C:\TNIP Carbon Counter v1.0\Data\TNIP Aircraft Jan 2010.csv
AIRCRAFT JETPROP MODEL SEATS
525B J Embraer EMB140 5
77L J B777-200 301
A6 J F28 0
A109 O Helicopters 0
A119 O Helicopters 0
A124 J B747-100 0
A139 O Helicopters 0
A306 J A310 266
A310 J A310 240
A319 J A320 124
A320 J A320 148
A321 J A320 185
A330 J A330 253
A332 J A330 253
A333 J A330 295
A340 J A340 261
A342 J A340 261
A343 J A340 295
A345 J A340 313
A346 J A340 380
A37 J Embraer EMB140 1
A380 J A380 469
A388 J A380 470
Step
Vault
Close

**Figure 17 Aircraft Data File Setup interface**

Navigate to the Aircraft (Substitute) file to be loaded and then press the **Open** button on the file dialog box. This will cause the aircraft in the file to be loaded. It is necessary to select an Aircraft (Substitute) file even if only the Fuel Burn file needs to be reloaded.

### Undefined Aircraft

The loaded movements are first checked to determine if any aircraft not defined in the Aircraft file have been loaded. If any undefined aircraft exist, a message advising of the undefined aircraft will be displayed and the option given to correct the problem aircraft. If the user selects **Yes**, the **Undefined Aircraft** interface will be displayed (***Figure 18***) where the user can define any unidentified aircraft shown in box **[A]**. The user can select these individually or use the shift and control keys to select common groups that can be defined by clicking on the appropriate button at **[B]**. Depending on the selection at **[B]**, clicking on the modified button at **[C]** (either Define - Jet, Define - Prop or Define - Other) will define the selected aircraft to the relevant type temporarily - for the current allocation process only. Depending also upon the selection in **[B]**, using the relevant button at **[D]** writes the selected aircraft types to the Aircraft (Substitute) file and makes the change permanent.

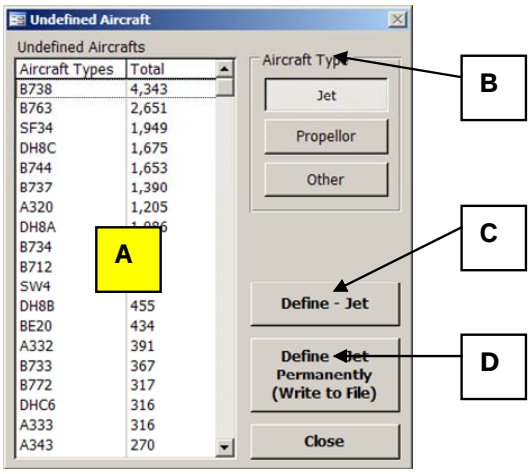



**Figure 18 Undefined Aircraft interface**

### Fuel Burn

When undefined aircraft have been dealt with, a check is made for the presence of a Fuel Burn file. If a Fuel Burn file (**FB.CSV**) is found at the location containing the Aircraft file, the user will be

prompted to confirm replacing the currently loaded aircraft substitution fuel burn specifications with those found in the file just found. If **Yes** is selected the current details will be overwritten.

**Substitutions**

Next the user will be asked to automatically define the substitutions for the aircraft being loaded with the setting as defined in the Aircraft (Substitute) file. Clicking **Yes** will load the aircraft and set up the substitutions based on the file settings. Clicking No at this stage will still load the aircraft, however, current substitutions will not be altered.

Once the process to automatically define the substitutions has been completed, a message will be displayed showing the aircraft types that were substituted.

This completes the loading of both the Aircraft (Substitute) file and the Fuel Burn file.

This interface can also be accessed via the **Airport Setup Menu** by selecting the Aircraft Substitutions button (Area B in ***Figure 8***).

### 3.3.4 Edit Existing Fuel Burn Data

The Fuel Burn button on the **Aircraft Substitutions** screen (***Figure 16***) brings up the **Enroute Fuel Burn** interface shown in ***Figure 19***. This interface can also be accessed from the Aircraft Fuel & Emissions button on the **Advanced Setup** screen shown in ***Figure 8***.

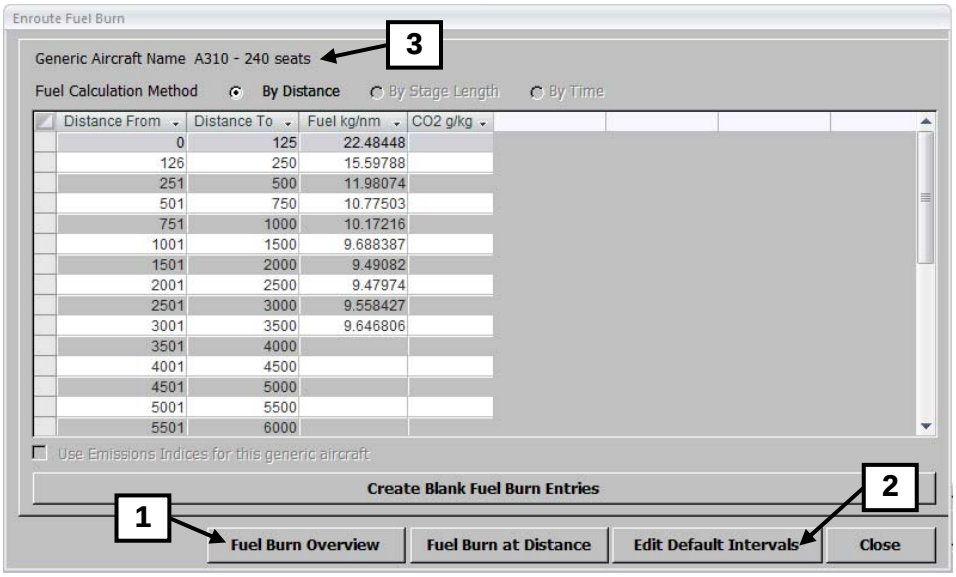



**Figure 19 En-route Fuel Burn interface**

This interface is very important to the functioning of TNIP Carbon Counter as it is used to store both PAX information and fuel burn parameters for each CORINAIR aircraft type.

**Seats**

For each generic aircraft type, the user is required to enter the number of seats. If no seat information for an aircraft is included in the Aircraft (Substitutions) file (see ***Figure 14*** column D titled: **SEATS**) the value displayed here **[3]** in the **En-Route Fuel Burn** screen (***Figure 19***) is used by the program to compute the 'per passenger' metrics output by the program.

### Fuel Burn

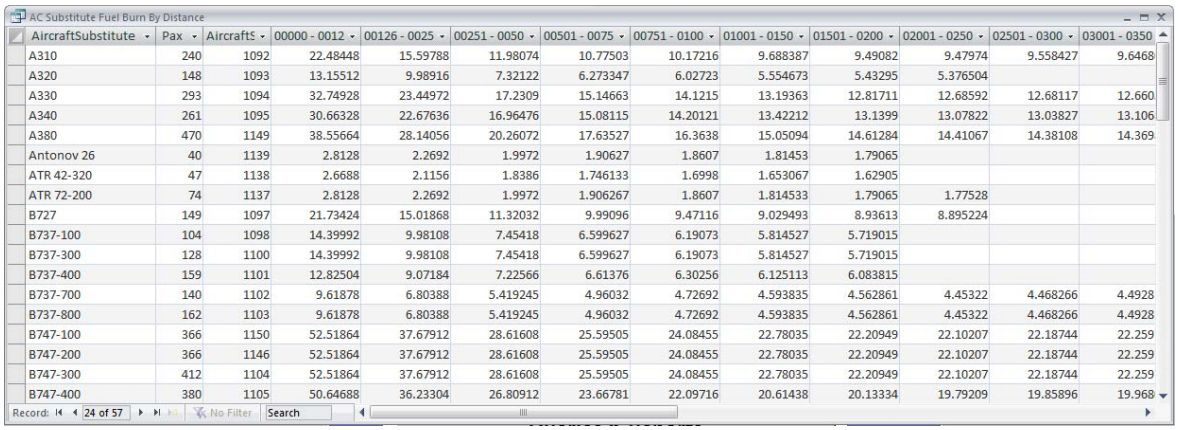
The fuel information is entered in the form of a fuel consumption rate for a series of discrete ranges each with a minimum and maximum distance. As discussed in ***Subsection 3.3.2*** the data in these columns indicates the absolute fuel burn in kilograms per nautical mile (kg/nm) for the maximum distance covered by the range of the column.

The fuel burn per nautical mile for all distances in a range, other than the maximum, are interpolated based on the maximum of that range and the previous one.

Each distance range is unique and no distance can be allowed to be covered by more than one column.

The default information that has been entered into the program has been extracted from the EMEP/CORINAIR dataset (see ***Appendix A***) where the EMEP/CORINAIR fuel burn values have been converted from a total fuel burn amount (for the band's maximum distance) to a fuel burn per nautical mile figure for that distance.

Selecting the **Fuel Burn Overview** button at **[1]** in ***Figure 19*** brings up the Microsoft Access table show in ***Figure 20*** .



AC Substitute Fuel Burn By Distance

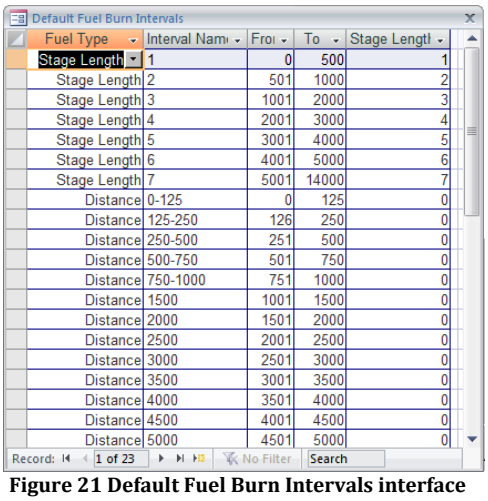
| AircraftSubstitute | Pax | AircraftS | 00000 - 0012 | 00126 - 0025 | 00251 - 0050 | 00501 - 0075 | 00751 - 0100 | 01001 - 0150 | 01501 - 0200 | 02001 - 0250 | 02501 - 0300 | 03001 - 0350 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A310 | 240 | 1092 | 22.48448 | 15.59788 | 11.98074 | 10.77503 | 10.17216 | 9.688387 | 9.49082 | 9.47974 | 9.558427 | 9.6468 |
| A320 | 148 | 1093 | 13.15512 | 9.98916 | 7.32122 | 6.273347 | 6.02723 | 5.554673 | 5.43295 | 5.376504 | | |
| A330 | 293 | 1094 | 32.74928 | 23.44972 | 17.2309 | 15.14663 | 14.1215 | 13.19363 | 12.81711 | 12.68592 | 12.68117 | 12.660 |
| A340 | 261 | 1095 | 30.66328 | 22.67636 | 16.96476 | 15.08115 | 14.20121 | 13.42212 | 13.1399 | 13.07822 | 13.03827 | 13.106 |
| A380 | 470 | 1149 | 38.55664 | 28.14056 | 20.26072 | 17.63527 | 16.3638 | 15.05094 | 14.61284 | 14.41067 | 14.38108 | 14.369 |
| Antonov 26 | 40 | 1139 | 2.8128 | 2.2692 | 1.9972 | 1.90627 | 1.8607 | 1.81453 | 1.79065 | | | |
| ATR 42-320 | 47 | 1138 | 2.6688 | 2.1156 | 1.8386 | 1.746133 | 1.6998 | 1.653067 | 1.62905 | | | |
| ATR 72-200 | 74 | 1137 | 2.8128 | 2.2692 | 1.9972 | 1.906267 | 1.8607 | 1.814533 | 1.79065 | 1.77528 | | |
| B727 | 149 | 1097 | 21.73424 | 15.01868 | 11.32032 | 9.99096 | 9.47116 | 9.029493 | 8.93613 | 8.895224 | | |
| B737-100 | 104 | 1098 | 14.39992 | 9.98108 | 7.45418 | 6.599627 | 6.19073 | 5.814527 | 5.719015 | | | |
| B737-300 | 128 | 1100 | 14.39992 | 9.98108 | 7.45418 | 6.599627 | 6.19073 | 5.814527 | 5.719015 | | | |
| B737-400 | 159 | 1101 | 12.82504 | 9.07184 | 7.22566 | 6.61376 | 6.30256 | 6.125113 | 6.083815 | | | |
| B737-700 | 140 | 1102 | 9.61878 | 6.80388 | 5.419245 | 4.96032 | 4.72692 | 4.593835 | 4.562861 | 4.45322 | 4.468266 | 4.4928 |
| B737-800 | 162 | 1103 | 9.61878 | 6.80388 | 5.419245 | 4.96032 | 4.72692 | 4.593835 | 4.562861 | 4.45322 | 4.468266 | 4.4928 |
| B747-100 | 366 | 1150 | 52.51864 | 37.67912 | 28.61608 | 25.59505 | 24.08455 | 22.78035 | 22.20949 | 22.10207 | 22.18744 | 22.259 |
| B747-200 | 366 | 1146 | 52.51864 | 37.67912 | 28.61608 | 25.59505 | 24.08455 | 22.78035 | 22.20949 | 22.10207 | 22.18744 | 22.259 |
| B747-300 | 412 | 1104 | 52.51864 | 37.67912 | 28.61608 | 25.59505 | 24.08455 | 22.78035 | 22.20949 | 22.10207 | 22.18744 | 22.259 |
| B747-400 | 380 | 1105 | 50.64688 | 36.23304 | 26.80912 | 23.66781 | 22.09716 | 20.61438 | 20.13334 | 19.79209 | 19.85896 | 19.968 |

Record: 24 of 57 No Filter Search

**Figure 20 Sample Fuel Burn Report**

This shows the table sitting under the previous interface and facilitates making a rapid fuel burn cross comparison between different aircraft types.

The **Edit Default Intervals** button at **[2]** in ***Figure 19*** gives access to the interface at ***Figure 21***.



Default Fuel Burn Intervals

| Fuel Type | Interval Nam | Fro | To | Stage Length |
|---|---|---|---|---|
| Stage Length | 1 | 0 | 500 | 1 |
| Stage Length | 2 | 501 | 1000 | 2 |
| Stage Length | 3 | 1001 | 2000 | 3 |
| Stage Length | 4 | 2001 | 3000 | 4 |
| Stage Length | 5 | 3001 | 4000 | 5 |
| Stage Length | 6 | 4001 | 5000 | 6 |
| Stage Length | 7 | 5001 | 14000 | 7 |
| Distance | 0-125 | 0 | 125 | 0 |
| Distance | 125-250 | 126 | 250 | 0 |
| Distance | 250-500 | 251 | 500 | 0 |
| Distance | 500-750 | 501 | 750 | 0 |
| Distance | 750-1000 | 751 | 1000 | 0 |
| Distance | 1500 | 1001 | 1500 | 0 |
| Distance | 2000 | 1501 | 2000 | 0 |
| Distance | 2500 | 2001 | 2500 | 0 |
| Distance | 3000 | 2501 | 3000 | 0 |
| Distance | 3500 | 3001 | 3500 | 0 |
| Distance | 4000 | 3501 | 4000 | 0 |
| Distance | 4500 | 4001 | 4500 | 0 |
| Distance | 5000 | 4501 | 5000 | 0 |

Record: 1 of 23 No Filter Search

**Figure 21 Default Fuel Burn Intervals interface**

This lets the user enter the bounds of the distance ranges. It also lets the user set up distance bands in the form of 'Stage Lengths' (this enables, for example, the user to set up distance zones which are common to those used in the FAA's Integrated Noise Model (INM)). This facilitates, for example, the use of common datasets for assessing both aircraft noise and carbon footprints in environmental assessments (see ***Section 12.3 Example 3: Environmental Impact Assessment (EIA)***).

## 3.4 Other Settings

The Advanced Setup button on the main menu brings up the **Advanced Setup** menu displayed in ***Figure 22***. This sub menu can be used to edit setup data for five separate areas of the Carbon Counter.

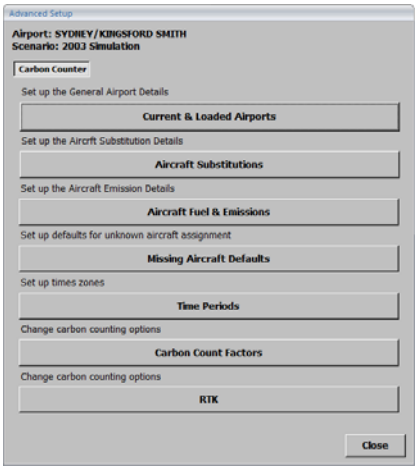



**Figure 22 Advanced Setup**

The first three buttons were addressed above in the sections on Airport Setup and Aircraft Setup. Current & Loaded Airports was discussed in ***Subsection 3.2.2*** and is also accessible from the main menu. Aircraft Substitutions was discussed in ***Subsection 3.3.3***, and is also available from the main menu. Aircraft Fuel & Emissions was discussed in ***Subsection 3.3.4*** and is accessible from the **Aircraft Substitutions** screen by clicking the Fuel Burn button.

The remaining two buttons are discussed in the following two Subsections.

### 3.4.1 Missing Aircraft Defaults

In some datasets the aircraft field for an entry in the movements file may be missing. In these circumstances the program will calculate the fuel use (and hence carbon) for these operations using a substitute aircraft type. This substitution, known as the **Missing Aircraft Defaults** is based on the distance that is travelled by the unknown aircraft during the identified movement.

Pressing the Missing Aircraft Defaults button on the **Advanced Setup** menu opens a Microsoft Access table listing the default aircraft to be used in these circumstances. The initial settings for the default aircraft can be seen in the table at ***Figure 23***. By default, three distances bands in kilometres are initially set up (0-1000, 1001-5000 & 5001-20000) with each band set to small (DH8), medium (B737) and large (B747)

| From (km) | To (km) | Aircraft |
|---|---|---|
| 0 | 1000 | DH8 |
| 1001 | 5000 | B737 |
| 5001 | 20000 | B747 |

**Figure 23 Default (Unknown) Aircraft**

aircraft respectively.

Specifically, the **Missing Aircraft Defaults** are used by the **Data Input & Pre-processing** interface when loading movement data and when an entry in the column specifying the aircraft type is missing and not known.

The table is organised so that a band of distances is supplied in a **From** and **To** column. Each of these bands has an aircraft associated with it. When data is loaded via the **Data Input & Pre-processing** screen each movement that does not have an aircraft will not have trip distances calculated unless the **Data Input & Pre-processing** checkbox (Aircraft Unknown) has been checked and the **Missing Aircraft Defaults** entries have been setup.

### 3.4.2 Time Periods

Pressing the Time Periods button on the **Advanced Setup** menu opens the Edit Time Periods interface, which can be used to create or edit the time ranges used by time based Save Points and reports.

### 3.4.3 Carbon Count Factors

To access the factors used for carbon counting press the Carbon Count Factors button on the **Advanced Setup** screen. You will then be presented with the screen shown at ***Figure 24***.

This screen is used to modify three different options: The unit and price of carbon per tonne; the specific gravity (SG) of fuel which is used to convert kilograms into litres; and the fuel to carbon conversion factor which is used to compute the amount of carbon produced from a kilogram of fuel.

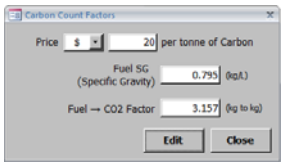



**Figure 24 Carbon Count Factors screen**

### 3.4.4 RTK

Computations of revenue tonne kilometres (RTK) requires the adoption of a number of factors. The **RTK** screen show in ***Figure 25*** enables the user to input the parameters which are used to calculate RTK.

To open the RTK screen (***Figure 25)*** press the RTK button on the **Advanced Setup** screen. There are two sections to this screen, both of which are needed to compute the freight weight component of the RTK calculations. The top section has a single field and is used to enter the average weight per passenger in kilograms. The next section contains five fields which deal with the percentages of passenger to freight weights for the three stages of flight; short, medium & long haul.

The field in the first section is used to enter the average weight of each passenger including all baggage they have. Calculating the 'Total Weight of all Passengers' involves calculating the total number of passengers – *'load factor' by 'number of seats' by 'number of flights'* - and multiplying this by the number supplied in the field. The number here is represented in kilograms.

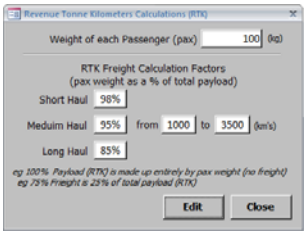



**Figure 25 Setup screen for RTK**

By knowing the ‘% of the Total Payload’ attributed to passengers we can work backwards from the known ‘total passenger weight’ to arrive at the ‘Total Payload’. By subtracting the ‘total passenger weight’ from ‘Total Payload’ we arrive at the ‘Total Freight Weight’. All RTK calculations can now be performed.

# Chapter 4

# The Data Vault

## 4.1 Introduction

Once the airport, aircraft and other key parameters have been set up, a data vault has to be generated.

The Data Vault is the archive for the aircraft movements datasets that are loaded into the program. Establishing a vault minimises the time taken to load files and assists in avoiding mismatching errors. This is achieved by archiving all the relevant files in a prepared format that enables the user to switch rapidly between the archived movements.

TNIP Carbon Counter is designed to be capable of storing and processing very large databases (millions of movements at thousands of airports). The data vault avoids the 2 gigabyte file size restriction inherent in Microsoft Access by breaking down the data into 'bite size pieces' that can be handled by a standard personal computer.

The main functions of the Data Vault are to provide a central data repository which enables the user to:

- Set up multiple airports with different parameters for each one.
- Load one or more movement files into each airport and then quickly view the movements in each loaded movement set.
- Build, store and retrieve multiple Save Points for each movement file loaded.
- Automatically restore all the relevant airport details and Save Points when activating movement sets.
- Analyse the data from one or more of the movement files individually or combined into various subsets.

In effect, the Vault is a repository for storing and quickly retrieving a large number of aircraft movement files for one or a large number of different airports and archiving them using a simple tree style interface. The number of airports and movements that can be contained in a Vault is basically only limited by the amount of available hard disk storage space. After one or more aircraft movement files are loaded the last one loaded will be automatically made the 'active' file. The user is able to switch the active movements at any time. Additionally, the program allows multiple Vaults to be set up with different airports, movements and settings specific to themselves and independent of other vaults.

Prior to loading data the user must have prepared all the necessary setup data files as described in Chapter 3.

## 4.2 The Vault Interface

Selecting the

button on the main menu (***Figure 8***) brings up the interface shown in ***Figure 26***.

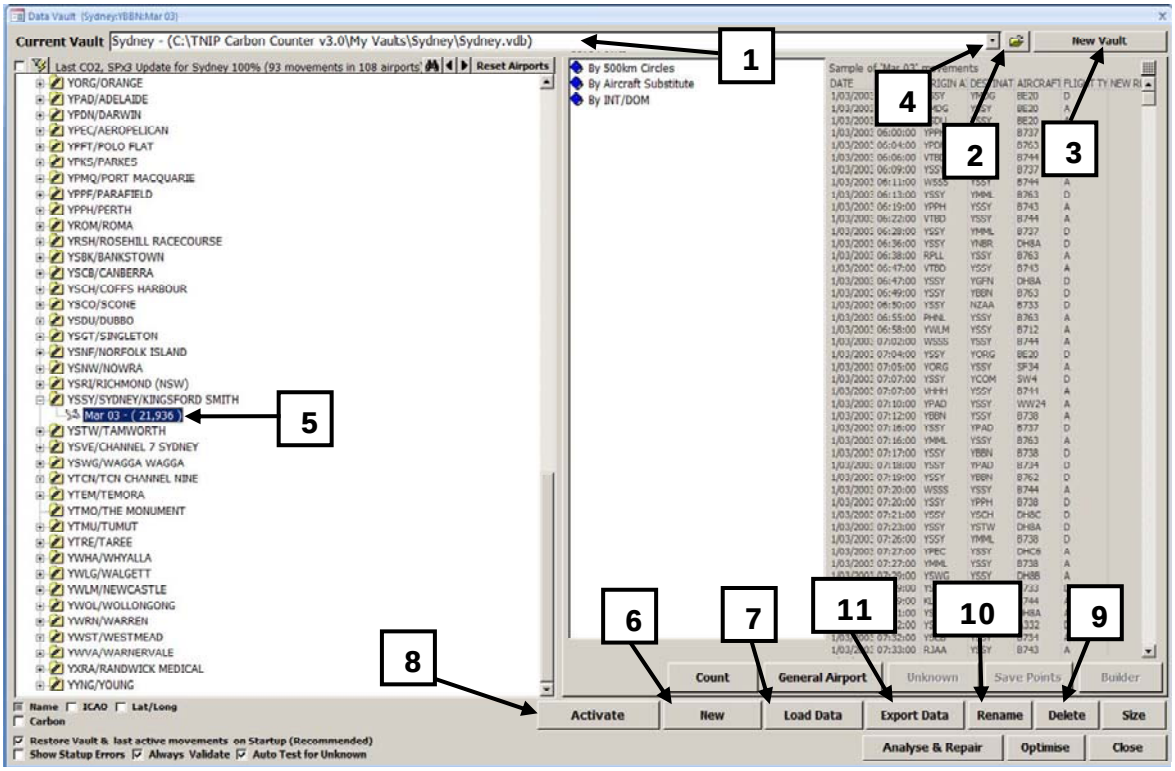



**Figure 26 Data Vault interface**

The address of the current Vault is shown at **[1]**. Other Vaults can be located using the browse button at **[2]** or new Vaults can be created by selecting the **New Vault** button at **[3]**.

Clicking the **New Vault** button **[3]** brings up the **Create New Vault** dialog box shown in ***Figure 27*** which allows the user to create three different Vault types.

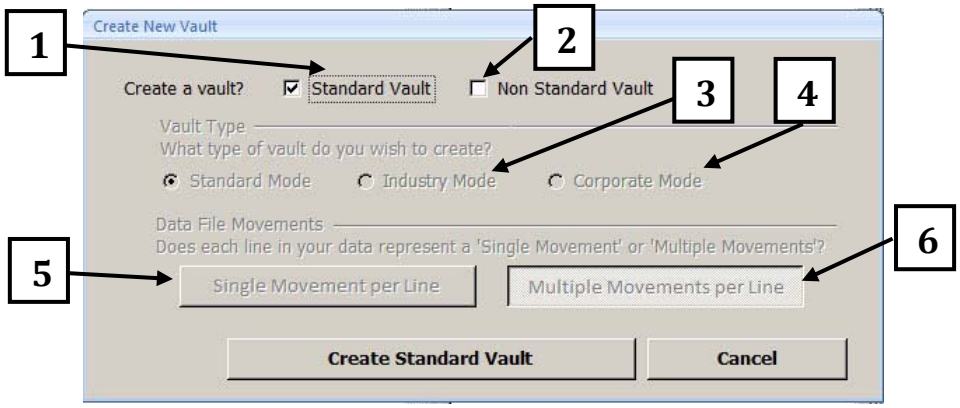



**Figure 27 Create New Vault dialog**

By default, the **Standard Vault** **[2]** is created for reading in a standard TNIP aircraft movements data file. Checking the **Non Standard Vault** option **[2]** allows the user to set up two other vault types: (i) an **Industry Mode** vault **[3]** where the data input files contain the actual fuel use per flight or (ii) a **Corporate Mode** vault **[4]** where the input files contain travel data for a company's employees. The format and types of input data are discussed in ***Section 5.2***.

For each of the three Vault types, the user then needs to select whether the Vault will contain aircraft movement files where each line in the files represents (i) a single aircraft operation **[5]** or (ii) a number of aircraft movements **[6]**.

Returning to ***Figure 26***, when the user browses for existing data Vaults, the program will perform a scan from the selected location and display a list of available Vaults in the dropdown list **[4]** where the user can then select an appropriate one from this list. Alternatively another location can be browsed to find additional Vaults using the button. When a valid Vault has been selected and the Vault is opened this list will contain only one item – the current Vault. To populate this list again perform another browse. If, after a browse operation, only one Vault is found it is loaded automatically.

During the loading process the program examines the data being loaded and checks its integrity. If a Vault database is missing, corrupted or not in the correct format the program will attempt to correct the problem and a message will be displayed informing the user of the problem and whether the problem has been fixed.

When activating movement sets, the Vault attempts to avoid a number of potential problems related to undefined aircraft types or airport codes. The carbon associated with movements in undefined aircraft types or at undefined airports will not be computed and hence the carbon counts will be under reporting. Therefore it is strongly recommended that the user completely work through the data integrity checking processes initiated by the program during the activation process. This is discussed in ***Subsection 4.5.3***.

Please note the following definitions: the loaded movement file data will be referred to as *movements*. When specifically referring to the movement container or place holder (see Vault Structure Overview in ***Section 4.3***) this manual will refer to them as a movement set, movement container or simply container.

## 4.3 Vault Structure Overview

Both the airport and the movement container are stored and accessed via the tree structure in the 'Airport Movements in the Vault' list **[5]** from the Data Vault interface. Folders exist to help the user further organise and group airports and movements. Adding a folder, an airport or a movement container is done by selecting the New button **[6]**. This button brings up the dialog box in ***Figure 28***. When adding to the top level the Movements button is disabled.

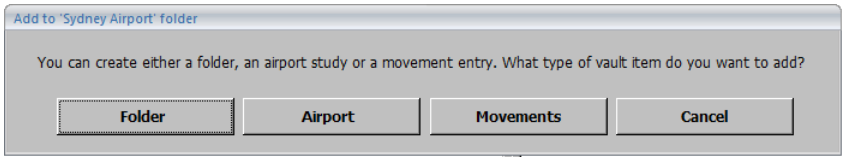

Add to 'Sydney Airport' folder
You can create either a folder, an airport study or a movement entry. What type of vault item do you want to add?
Folder
Airport
Movements
Cancel

**Figure 28 Add to Vault dialog**

In summary the function of each item that can be added are:

- A **Folder**: Used as a simple folder-like container for one or more airports or movement sets. These appear as standard yellow folders ( 1990 Annual ). Folders can be nested and help to organise or document the tree by using clear and simple descriptions.

  E.g. 'The World', 'Australia', 'Asia Pacific', '2000 Movements' & '1990 Annual'.

- An **Airport**: Used to group together any number of movement datasets which are all related to the same airport. These appear as yellow folders with a picture of a runway (Sydney). Details specific to the airport will relate to all movement sets loaded under it. These details include: airport name, latitude/longitude and a listing of the ICAO country codes prefixes for the airport.

- A **Movement Set**: This is the container (or placeholder) that is used to store actual data for a movement dataset and cannot be created at the top level. These appear as an aircraft to signify they are movements (1998 - ( 282,893 )). The number of movements is displayed in brackets. When activating a movement set, highlight the container and then select the 'Activate' button **[8]** in ***Figure 26***. Similarly, to perform other vault actions, such as loading data, counting carbon, renaming or deleting movement sets, first select the movement set and then click the relevant button. For more information on these actions refer to the relevant parts in this chapter.

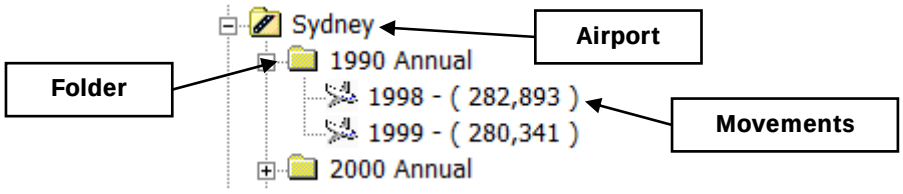



**Figure 29 Vault tree structure**

The example above shows that 'Sydney' airport has been created (yellow folder with a runway **[Airport]**) with two sub folders '1990 Annual' and '2000 Annual' (plain yellow folders **[Folder]**). The '1990 Annual' folder has two movement sets loaded under it: '1998' and '1999' (represented by the aircraft **[Movements]**) having 282,893 and 280,341 movements respectively.

## 4.4 Loading Data into the Vault

Once a data vault is set up, the next step is to load data. The standard (and recommended) procedure for loading data is to exit from the Data Vault interface and enter the **Data input & Pre-processing** interface by selecting the similarly named button on the Main Menu (***Figure 8***). This interface provides the preferred route for loading aircraft movement data sets into the program. This is discussed in detail in ***Chapter 5***.

However, the program does provide the user with the ability to load data for individual airports from the Data Vault interface once a container (represented by an aircraft icon) has been set up. A movement data file can be loaded into the container by highlighting the aircraft icon and selecting the Load Data button **[7]** on the Data Vault interface (***Figure 26***). This may be a useful shortcut for experienced users.

Once data is loaded, the user can directly proceed to interrogating the data using the **Queries and Reports** interface accessed via the **Queries & Reports** button on the Main Menu (***Figure 8***). Alternatively, as discussed in the next section, data can be 'activated' and its integrity checked prior to interrogation.

## 4.5 Activating and Checking Movement Data

### 4.5.1 Movement Activation

TNIP Carbon Counter provides two ways of storing, counting and analysing data: either directly using the internal TNIP Carbon Counter tables or from movements inside the current Vault. The internal tables are active when the program is first started, whenever no Vault movement has been made active or when a problem exists with the current Vault which cannot be resolved automatically. To identify the currently active Vault movement its name and reference is placed in the title bar of various interfaces.

Once one or more files have been loaded into the Vault, return to the **Data Vault** (*Figure 26*) and, after ensuring the proper movement container is highlighted press the **Activate** toggle button **[8]**. Depending upon whether the movements are already active or not you may see either one of the toggle buttons *Figure 30* or *Figure 31*.

**Activate**


If the highlighted movement container is not already activated the 'Airport Setup' button will be greyed out and the Activate/De-Activate button below it will display the word **Activate** as in *Figure 30*.

**Figure 30 Activate Button (Activate)**

**Deactivate**


If the highlighted movement container is already activated the 'Airport Setup' button appears as normal and can be selected and the Activate/De-Activate button below it will display the word **De-Activate** as in *Figure 31*.

**Figure 31 Activate Button (De-Activate)**

### 4.5.2 Activated Movements

When a valid container is selected and made active, the title bar on various screens (including the **Data File Setup** screen) will be modified to specify the name of the Vault, airport and movement that is active. This is done by displaying each of these parts, separated by a colon, and then enclosing them in braces **{...}**. The first part will be the Vault name: the second part will be the airport name: the third part will be the movement container name.

The screen shot *Figure 32* is an example from the **Data File Setup** screen and shows that the March 2003 movement set for Sydney Airport from the Sydney Vault is currently active.

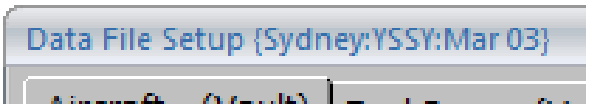



**Figure 32 Window Title Showing Active Vault**

### 4.5.3 Data Integrity Checking

The program provides two opportunities for identifying potential problems related to movement sets and subsequent problems when performing a carbon count. This integrity checking occurs when data is loaded and, by default, every time a movement set is activated.

### Data Loading - Aircraft Integrity Check

During the loading of movement data, via the **Data File Setup** interface, if missing or undefined aircraft types are detected the dialog in ***Figure 33*** appears which enables the user to update the aircraft type file.

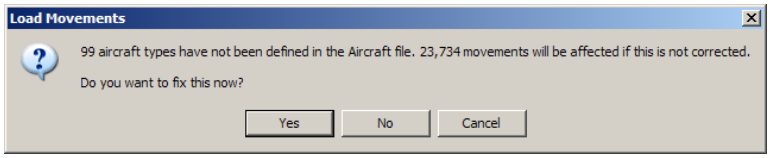

Load Movements
99 aircraft types have not been defined in the Aircraft file. 23,734 movements will be affected if this is not corrected.
Do you want to fix this now?
Yes
No
Cancel

**Figure 33 Undefined Aircraft dialog**

Selecting **Yes** brings up the **Undefined Aircraft** screen (***Figure 18***). For a more in-depth discussion of this refer to ***Subsection 3.2.4***. This interface can also be displayed by clicking the button on the **Aircraft** tab of the **Data File Setup** interface. (The **Data File Setup** interface displayed in *Error! Reference source not found.* does not display the **Aircraft** tab therefore the button is not visible).

### Data Loading - Airport Integrity Check

If there are unrecognised airport codes in the loaded aircraft movement file the user is presented with the dialog shown in ***Figure 34***.

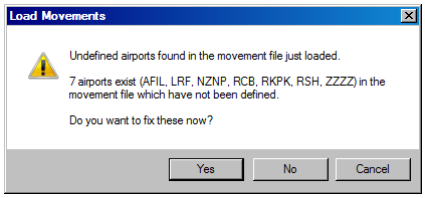

Load Movements
Undefined airports found in the movement file just loaded.
7 airports exist (AFIL, LRF, NZNP, RCB, RKPK, RSH, ZZZZ) in the movement file which have not been defined.
Do you want to fix these now?
Yes
No
Cancel

**Figure 34 Loaded Movements dialog**

Selecting **Yes** from this dialog will bring up the **Undefined Airports** screen (***Figure 13***). For a more in-depth discussion of this refer to ***Subsection 3.3.3***.

### Movement Activation – Undefined Integrity Check

Upon movement activation the program again checks to see if there are any unidentified movements due to unknown aircraft or unknown airports. For large movement sets (e.g. 1 Year) there will be a few seconds pause before the movement set is activated as the program checks each movement against the airports and aircraft data files that have been loaded. If unidentified movements exist, the **Unknown Movements Summary** interface is displayed in ***Figure 35***. From this interface the user can examine the undefined movements and identify which ones can be fixed.

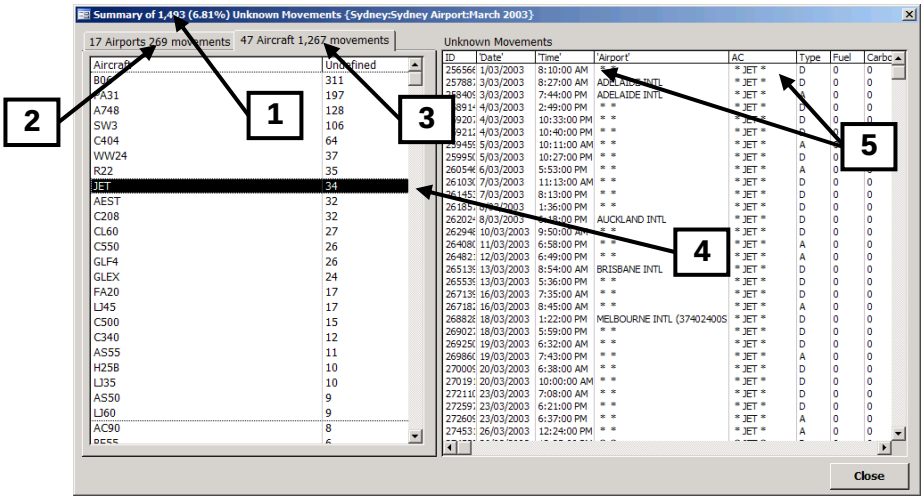



**Figure 35 Unknown Movements interface**

There is a check box at the bottom of the **Data Vault** screen (shown in ***Figure 26***) titled **Auto Test for Unknown** which, by default, is turned on. If unchecked the program will not perform validation during activation. For new movements, movements not activated for some time, or where their integrity is otherwise unknown, it is recommended that this be turned on before activating these movements.

Depending upon the number of unknown movements and why they are unknown the user will see either one or both of the tabs displayed in the interface.

To view the actual movements that are unknown select either the **Airports** **[2]** or **Aircraft** **[3]** tab, then click one of the entries in the list **[4]**. The Unknown Movements list on the right hand side will be updated with the movements that are 'unknown' based on the airport or aircraft item selected in the left hand list. Unknown airports and aircraft are surrounded by a ' * ', e.g. * JET * * * when blank.

The list on the left is ordered by the number of undefined movements pertaining to the group and the list on the right is ordered by the date and time of the movements.

The title bar displays the total number of discrete undefined movements as a total **[1]** and as a percentage of all movements loaded. This provides a quick assessment of the impact of all undefined movements. Please note that the total number of movements in the tab titles (in the screen shot: Airports 269 **[2]** & Aircraft 1,267 **[3]**) do not necessarily add up to the total number of movements **[1]** displayed in the title bar since a single movement may have both an unknown aircraft as well as an unknown airport – as a result adding these two numbers will result in possible double counting.

Looking at ***Figure 35*** an example of this can be found after JET is selected in the list on the left **[4]** and, looking at the list on the right, the first item in the list **[5]** shows an arrival from an unknown airport ( * * : blank) in the unknown JET aircraft ( * JET * : JET).

No editing or changing of the movements can be done from this interface. It is provided solely as an aid to alert, identify and enable the user to determine which movements should be corrected in order to eliminate undefined movements. To fix either undefined airports or aircraft refer to Airport Set Up in ***Chapter 3 Program Setup***.

## 4.6 Vault Maintenance

As the Vault is used, with files being loaded, carbon being counted and Save Points being created and deleted the Vault may become fragmented, especially when disk space is limited or the computer is accessing the disk while TNIP Carbon Counter is writing to the Vault. Over time this fragmentation will negatively impact on the speed of the program. To optimise performance it is important to ensure there is enough free space on the hard drive and it is defragmented regularly.

### Optimising the Vault

Over time, as files are loaded and reloaded, carbon counting and Save Points creation and deletion is performed, the vault will increase in size. Some calculated data is stored along with movement data in order to speed up access to the data. When movement sets are deleted neither the movement data nor the calculated data are removed until the Vault is optimised.

If a lot of work has been done with a particular movement set, carbon counting and Save Point creation, the user will often find it is useful to optimise the Vault for that particular movement set.

When work has been done to many or indeed all of the movement sets then it may be best to optimise the entire Vault.

If a Vault has hundreds of airports along with their related movements, this process can take an hour or more to complete. Because of the potential time delays caused by optimising the Vault, this process has not been automated and is up to the user to initiate.

If the program has slowed down or disk space is running low because of the Carbon Counter, it may be necessary to optimise the Vault. This function can be accessed via the Optimise button at **[9]** on the Data Vault interface in ***Figure 26***. The user will be prompted with a dialog asking if they wish to optimise the highlighted movement set or the entire Vault.

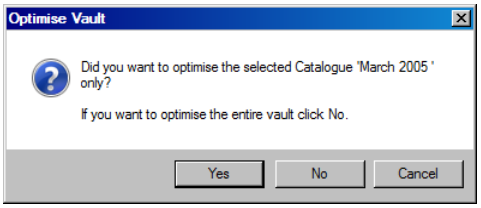

Optimise Vault
Did you want to optimise the selected Catalogue 'March 2005 ' only?
If you want to optimise the entire vault click No.
Yes
No
Cancel

**Figure 36 Optimise Vault dialog**

Selecting **Yes** from this dialog will only optimise the currently highlighted movement set, in this example 'March 03'. Optimising a single airport entry is a relatively quick operation. If the user chooses to optimise the entire Vault by selecting **No** they must then confirm this operation.

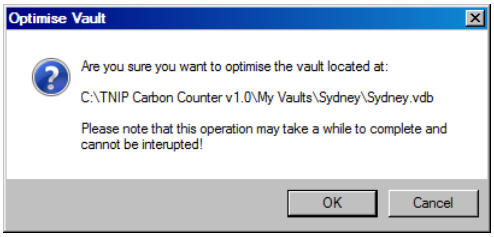

Optimise Vault
Are you sure you want to optimise the vault located at:
C:\TNIP Carbon Counter v1.0\My Vaults\Sydney\Sydney.vdb
Please note that this operation may take a while to complete and cannot be interupted!
OK
Cancel

**Figure 37 Optimise Vault confirmation dialog**

Depending upon the speed of the computer and if the Vault contains hundreds of airports and their related movements the process of optimising the Vault could take a significant amount of time, indeed, this process may take hours. During this time TNIP Carbon Counter cannot be used.

While it is possible to open two or more instances of the Carbon Counter and have each instance connect to the same Vault the user should ensure that this does not happen while the Vault is being optimised.

### Analysing and Repairing the Vault

During normal use of the Vault the program will check for inconsistencies and anomalies in the Vault and attempt to correct these problems without intervention from the user. To search for and correct all problems every time a Vault operation is done would slow things down too much; therefore automatic analysis is limited to basic checking only.

If problems are experienced with the Vault, particularly if an old Vault is being used after performing an upgrade of the program, it is strongly recommended that a Vault analysis be performed. More extensive checks will be made and it is possible that old Vault files which have out of date or obsolete data structures may be corrected and rendered usable.

It is recommended that the Vault is backed up first as this process makes actual changes to the structure of the Vault. If problems occur (such as power loss) during this 'analysis and repair' process, parts of the Vault may be left in an unusable state. When ready to proceed the user must open up the Data Vault interface and click on the Analyse & Repair button at **[10]**.

There are two types of analysis that can be performed, a fast analysis and repair, and a deep analysis and repair. Clicking the Analyse & Repair button will cause the first dialog, as displayed at the top in ***Figure 38***, to prompt the user with the name of the Vault being analysed and a warning that a deep analysis and repair may take a long time. Clicking the **Yes** button on this dialog performs a deep analysis and repair, whereas clicking **No** performs a quick analysis and repair only. Upon clicking either **Yes** or **No** a subsequent dialog (see the bottom two dialogs also displayed in ***Figure 38***) will ask if Vault optimisation should also be performed as part of the Analysis and Repair.

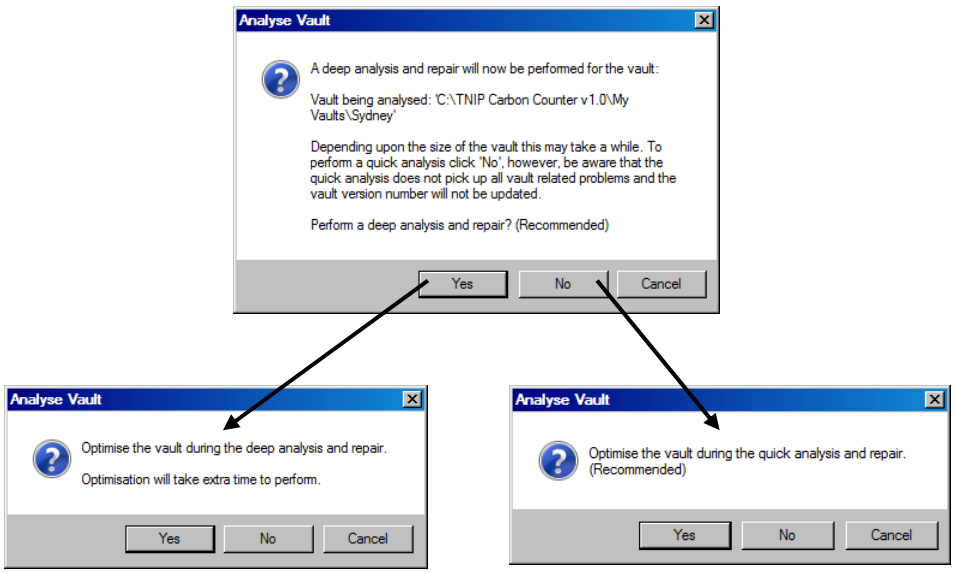

Analyse Vault
A deep analysis and repair will now be performed for the vault:
Vault being analysed: 'C:\TNIP Carbon Counter v1.0\My Vaults\Sydney'
Depending upon the size of the vault this may take a while. To perform a quick analysis click 'No', however, be aware that the quick analysis does not pick up all vault related problems and the vault version number will not be updated.
Perform a deep analysis and repair? (Recommended)
Yes
No
Cancel
Analyse Vault
Optimise the vault during the deep analysis and repair.
Optimisation will take extra time to perform.
Yes
No
Cancel
Analyse Vault
Optimise the vault during the quick analysis and repair. (Recommended)
Yes
No
Cancel

**Figure 38 Analyse Vault dialogs**

As with Vault Optimisation, this process may take a significant amount of time and neither the program nor the Vault can be used during this process. While it is impossible to predict the amount of time required (as this is dependent upon the size of the Vault and the number of problems), as a very rough guide this process may take anywhere between a minute for small vaults with few airports to a few hours for large ones with hundreds or thousands of airports and movements. This process cannot be interrupted.

During this process the user will be prompted with various dialog boxes regarding the state of the Vault and any work that needs to be done.  Problems that occur during this stage may be fixed automatically or may require user intervention to correct them.

# Chapter 5

# Data Input and Pre-processing

## 5.1 Introduction

This part relates to the loading and management of the datasets that form the basis for the carbon calculations and reporting carried out by the program.

TNIP Carbon Counter computes carbon footprints across an aviation network, or for a number of aircraft operations, through aggregating the $CO_2$ computed for each individual operation within a dataset. The data required is relatively simple and the datasets that are used to perform the footprinting are commonly generated within the aviation industry.

## 5.2 Aircraft Movements File

The aircraft movements file is a comma-separated text file and contains one line of data for each aircraft movement. The **Data File Setup** interface, as discussed in ***Section 4.4***, works with standard TNIP style movement files only. The **Data Input & Pre-processing** interface (***Section 5.3 Figure 41***) is far more flexible and is not restricted to the standard TNIP style movement files, rather it is able to work with three different file types and also provides flexibility in format and make-up of these files.

### 5.2.1 Data Formats

It is essential that the correct data format is selected from the outset of the data loading process. The four basic aircraft movement files that the **Data Input & Pre-processing** interface works with are **TNIP Standard**, **TNIP Departures Only**, **Combined Arrival and Departures** and **Segmented Trips** which can be found in section **[A]** in ***Figure 41***. These four formats, also shown in ***Figure 39***, are discussed below:

**Figure 39 Four movement file formats**

#### i ) Standard TNIP

This is the standard TNIP style movement file format. Each line is either an arrival or a departure. While these files contain runway information this is ignored by the Carbon Counter.

The default file header and required fields include:

**DATE, TIME LOCAL, ORIGIN AIRPORT, DESTINATION AIRPORT, AIRCRAFT TYPE, FLIGHT TYPE**

An extract of a standard TNIP movement's data file for Sydney Airport is shown in ***Figure 40***.

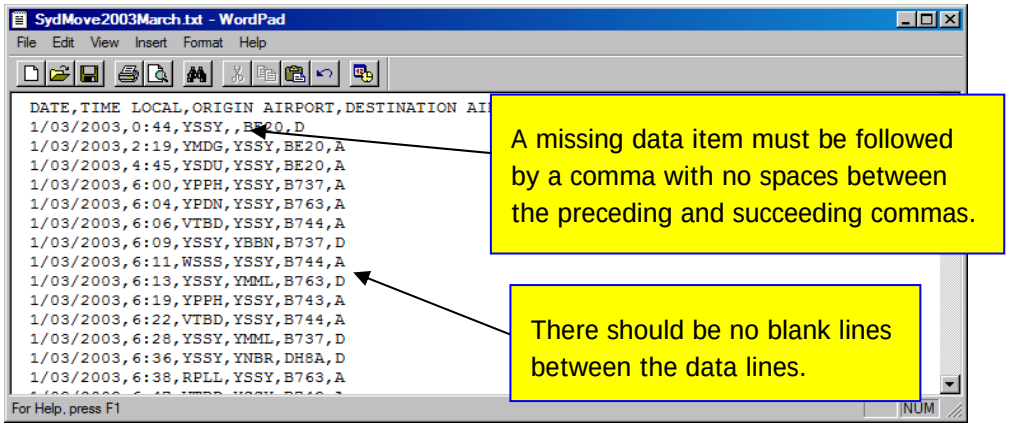



**Figure 40 Sample Standard TNIP Movement File**

### ii ) TNIP Departure Only

This is a standard TNIP style movement file. However, it is assumed that ALL entries in the file are departures, therefore the column [FLIGHT TYPE] does not need to be present.

**Caution**: If a standard TNIP file is used and this data format is selected, ALL arrivals will be loaded as departures. This has the potential of doubling the number of departures and hence doubling the carbon!

The default file header and required fields include:

**DATE, TIME LOCAL, ORIGIN AIRPORT, DESTINATION AIRPORT, AIRCRAFT TYPE**

### iii ) Combined Arrival/Departure

Each line in these data types can be considered as two distinct movements. Each line includes the departure date and time at the departure (i.e. ORIGIN) airport as well as the arrival data and time at the arrival (i.e. DESTINATION) airport. The program is able to construct the relevant movement entries for both the departure airport as well as the destination airport. There is no [FLIGHT TYPE] field required as each line is by definition both a departure and an arrival.

The default file header and required fields include:

**DEPT DATE, DEPT TIME, ORIGIN AIRPORT, ARR DATE, ARR TIME, DESTINATION AIRPORT, AIRCRAFT TYPE**

### iv ) Segmented Trips

This import type is currently under development and unavailable, however, when complete it will be used to load data files that are multi segmented trips. Each movement will have an initial origin and final destination airport and extra airports can be inserted into the movement between the origin and destination to simulate a trip that includes extra stops or diversions.

## 5.2.2 Field Definitions and Notes

The aircraft movement data files must use the following field formats:

**STANDARD FIELDS**

- **DATE**: as DD/MM/YYYY,
- **TIME**: as HH:MM (24 hours),
- **ORIGIN AIRPORT** & **DESTINATION AIRPORT**: 4 Characters – the ICAO Airport codes are generally used,

- **AIRCRAFT TYPE**: maximum of 6 characters should be used,
- **FLIGHT TYPE**: 1 character – either A (arrival) or D (departure)

**DATA OPTION SPECIFIC FIELDS –** Depending on the Data Options selected the following two options may be required:

- **DATE TIME LOCAL**: this field is required when combining the date and time into a single field.
  DD/MM/YYYY HH:MM (24 hours)
- **ORIGIN-DESTINATION-AIRPORT**: This field is required when selecting the Origin-Destination Data Option and is used to combine the ORIGIN AIRPORT and DESTINATION AIRPORT fields into a single field.
  The field is nine characters. A four-character ORIGIN AIRPORT code is placed first, followed by a hyphen '-', then followed by a four-character DESTINATION AIRPORT.

Several of the fields in the Standard TNIP and TNIP Departure Only aircraft movement files are redundant when carrying out computations using TNIP Carbon Counter. However, the format of these TNIP files have been deliberately retained since this allows a common dataset to be used for both aircraft noise and carbon footprint analyses using the TNIP family of software. This should be very useful, for example, in an EIA process where the future files developed for noise assessment can simply be loaded into TNIP Carbon Counter to carry out a rapid carbon footprint assessment (see worked example at ***Section 12.3***)

## 5.3 Introduction to Data Input and Pre-processing

The **Data Input and Pre-processing** interface, accessed by pressing the Data Input & Pre-processing button from the Main Menu, provides the user with a fully automated system of data loading, carbon counting and Save Point building without the need for user intervention.

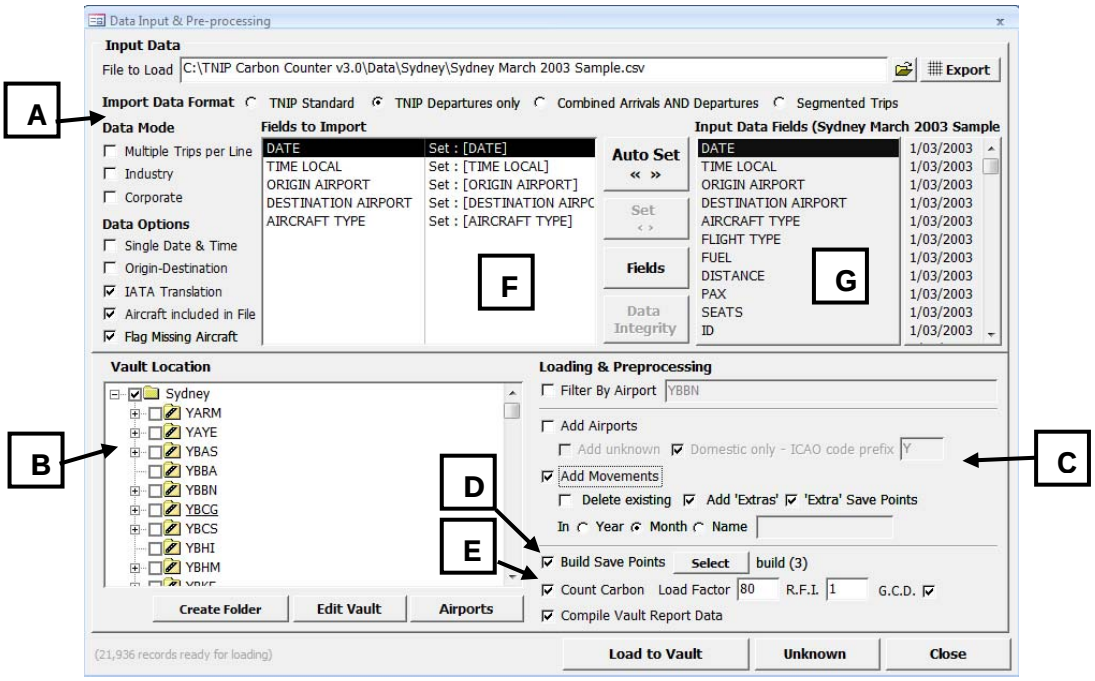



**Figure 41 Data Input and Pre-processing interface**

While the interface screen contains a number of parts and may at first glance appear complex it is relatively simple and can be considered to have five main functional parts that are marked on ***Figure 41***.

These functional parts of the interface are:

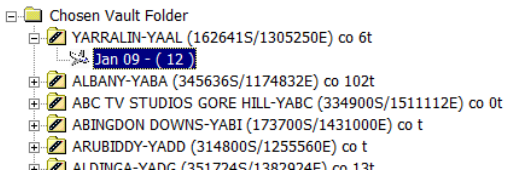
- **[A]** Data File Setup: Mandatory if a file is being loaded. Refer to ***Subsections 5.3.1-5.3.8***. For information on the specific file formats refer to ***Section 5.2***.
- **[B]** Vault Folder Location: Mandatory. Select the location of the vault to perform the work. Refer to ***Section 5.4***.
- **[C]** Data Loading Options: This section deals with the various options for adding Airports, Movements and Extra fields. If neither the ☑ Add Airports nor ☑ Add Movements options are checked, ***Section 5.3.1 Data File Setup*** and the remainder of ***Section 5.3*** can be skipped completely. Resume reading at ***Section 5.4*** , however, also note that the **Adding Airports** and **Adding Movements** parts of ***Section 5.5 Load Options*** can also be ignored.
- **[D]** Building Save Points Options: Required if Save Points are to be generated. Refer ***Section 5.6***.
- **[E]** Counting Carbon Options: Required if the carbon is to be counted. Refer to ***Section 5.7***.

If the selected Vault folder has existing movements, carbon counting (see ***Section 5.7***) and any Save Points to be built (see ***Section 5.6***) will also be carried out for the existing movements and not just new ones that are added. When two or more movement files are to be loaded one after the other it is best to delay counting carbon and Save Point building until the last of the movement files is loaded. This may save a significant amount of time and greatly reduces the amount of work the carbon counter must do.

Each section will now be discussed in more detail.

### 5.3.1 Data File Setup

The **Data Input and Pre-processing** interface provides the user with the flexibility to specify a movement file and then define which columns in the movement file relate to which required field. One benefit of using this interface, over the **Data File Setup** interface (refer to ***Section 4.4***), is that by using the **Data Input and Pre-processing** interface one file can contain movements for any number of airports for a 1-year period and can consist of millions of movement entries.


Chosen Vault Folder
YARRALIN-YAAL (162641S/1305250E) co 6t
Jan 09 - ( 12 )
ALBANY-YABA (345636S/1174832E) co 102t
ABC TV STUDIOS GORE HILL-YABC (334900S/1511112E) co 0t
ABINGDON DOWNS-YABI (173700S/1431000E) co t
ARUBIDDY-YADD (314800S/1255560E) co t
**Figure 42 Sample folder structure**

Additionally, the program automatically creates all airport entries and their respective movements in a standard tree structure underneath a folder defined by the user.

The other significant benefit of using the interface is that it is able to process a number of different movement file formats as discussed in the previous section.

### 5.3.2 File Selection – The Required Fields

To select the aircraft movements file that is to be loaded click the button (top right in *Figure 41*). Using the Windows file dialog navigate to the desired file, select it and then click the **Open** button. When a file has been selected the program will analyse the data and attempt to automatically match up the **Columns in the Input File** list (see **[G]** *Figure 41* – these fields come from the header line of the file just opened) with the **Required Fields** list **[F]** also in *Figure 41*. If all of the **Required Fields** **[F]** can be matched, all the entries in the list will become **'Set :'** and the text will change to **black**.

If any of the **Required Fields** **[F]** are not **'Set :'** the text in this list appears in **red**. Loading cannot be started until all fields are **'Set :'** and the list appears in **black**. See *Figure 43*.

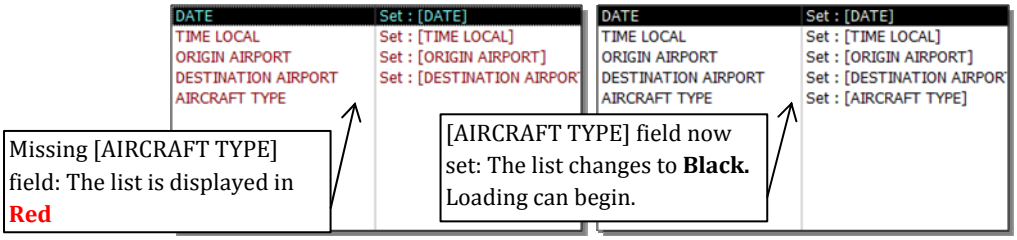



**Figure 43 Required Fields Unset & Set**

If the data file specified is the correct one, and the **Required Fields** list **[F]** (*Figure 41*) has some or all of its fields not **'Set'**, click the button and have the program check columns in the input file to automatically set these fields. If the correct file header names were used for all of the **Required Fields** **[F]** listed, the text will change from **red** to **black**.

If one or more of the fields cannot be set automatically and the list remains in **red**, a number of solutions are possible:

- Set the unset fields manually (*Subsection 5.3.4*),
- Select the correct data file type (*Subsection 5.3.3*)
- Eliminate or change the required fields by using one or more of the data options (*Subsection 5.3.5*)
- Correct the missing fields in the data file and reload the file or select another data file that has all of the required fields present.

It is important to note that when a file is selected the actual data in the file is preloaded and kept in the program. If changes are made to the file it must be loaded again.

### 5.3.3 Data Format

As discussed in the previous section there are three alternative data formats that the program can use: TNIP Standard, TNIP Departures Only and Combined Arrivals and Departures. Refer to *Section 5.2* with attention to *Subsection 5.2.1* for a complete description of the data formats available. However, extra fields can be added to any of the available data formats to generate user defined file formats, refer *Subsection 5.3.7*.

To specify which data format to use select its desired radio button in the Data Format Section. When the data format is changed the entries in the **Required Fields** list **[F]** (*Figure 41*) change to reflect the fields required for this data type.

Rather than automatically setting the required fields based on the currently specified and preloaded file the program will simple display the fields that were set the last time this data format was set up. If any of those fields are no longer available in the currently preloaded file these columns will not be displayed and must be set before the data load can begin.

As long as the correct header line has been used clicking the Auto Set button should correct this problem and data loading can begin.

### 5.3.4 Manually Setting Required Fields

If the **Required Fields** list **[F]** (*Figure 41*) appears in **red** and the Auto Set button does not correct the problem the user will have to manually set each unknown field in the list.

To manually set a required field the user must first highlight the field to be set and then highlight its corresponding field in the **Input Data Fields** list **[G]** (*Figure 41*). When both the required field and its related column have been highlighted clicking the Set button should result in the new setting appearing in the **Required Fields** list **[F]**. This procedure needs to be repeated until all columns have been set and the Required Fields list changes from **red** to **black**.

If all the **Required Fields** **[F]** cannot be set and the list remains **red** refer to *Subsection 5.3.2* for other ways to correct this problem.

If the list is currently displayed in **black** text, it is still possible that one or more of the fields has been set incorrectly and needs to be changed. To change an already set field simply highlight both the Required Fields list item which requires the change, and the new field to which it is to be set in the **Input Data Fields** list, and click the Set button to correct the problem.

### 5.3.5 Data Options

Problems with loading may mean that a data file cannot be used without some form of preprocessing. For example, a movement data file may not be available in the standard TNIP format; the file to be loaded does not contain all the required fields, or alternatively data in the existing file cannot be changed to a TNIP format easily.

The program allows for some flexibility in the required fields by allowing the date and time fields as well as the origin and destination fields to be combined into single fields. Additionally, if the aircraft type is missing the program can be made to fill in this blank by substituting an aircraft for each movement based on the distance flown.

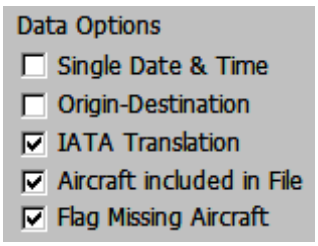



**Figure 44 Data Options (Data Input & Pre-processing Screen)**

The data options available can found on the **Data Input and Pre-processing** interface (**[A]** in *Figure 41*) or more clearly in *Figure 44*. Each of these options is discussed below.

#### Single Date & Time

By default the program requires separate fields for date and time to be supplied. If the data has a column which has the date and time combined into a single field rather than being split there are two options available. Either the single field in the data file can be split manually into two fields or this can be carried out by the program by clicking the Single Date & Time radio button under the

Options Section. Clicking this option will cause the **Required Fields** list to change and the Date and the Time fields will be collapsed into a single field called **[DATA TIME LOCAL]**.

When using the **Combined Arrival and Departure** data format the departure date and departure time fields are collapsed into a single field. Similarly, the arrival date and the arrival time fields are collapsed into a single field. With the ☐ Single Date & Time option checked these four fields will be reduced to only two fields.

### Single Origin and Destination

Airport movement datasets sometimes have the origin and destination fields combined into a single column with a hyphen for separation. If it is not possible to acquire the data in the standard TNIP style the program can be set up to work with the non-standard data format.

To use a single field for both the origin and destination field click the ☐ Origin-Destination check box.

To use the combined origin/destination field the data in the file must be formatted so that the origin airport appears first separated by a hyphen and then followed by the destination airport. The codes for these airports must be in ICAO format and four characters long. The total length of the field data should be nine characters.

### IATA Translation

By default the carbon count uses standard ICAO airport codes. If the data file being loaded uses IATA airport codes (e.g. datasets generated by corporate travel agents typically use IATA codes) this option can instruct the program to translate any three character airport code to its relevant ICAO code. The program will use the IATA codes that were defined in the Airports file and last loaded to determine these translations.

To turn this feature on and off toggle the state of the ☑ IATA Translation checkbox. By default, it is best to leave this option turned on.

### Missing Aircraft Type – Two Options

It may be common for aircraft movement files to have entries that are not complete or indeed missing. When the aircraft type is not know and cannot easily be found out, or guessed, the program can compensate for this by automatically inserting an aircraft type based on the distance from the origin airport to the destination airport.

When the aircraft type is not known for the entire file uncheck the ☑ Aircraft included in File checkbox (*Figure 44*) and the Aircraft Type field will be removed from the **Required Fields** list **[F]** (*Figure 41*) and the ☑ Flag Missing Aircraft options disappears. When the data file is loaded each movement will be flagged as unknown and the relevant **Missing Aircraft Defaults** (refer *Subsection 3.4.1*) will be substituted each time a carbon count is performed.

If the movement file to be loaded has information related to the aircraft type used for each movement, however, one or more of the entries is missing or unknown, first check the ☑ Aircraft included in File option and then check the ☑ Flag Missing Aircraft option to have the missing entry flagged and substituted using one of the **Missing Aircraft Defaults** during subsequent carbon counting.

To view or update the **Missing Aircraft Defaults**, return to the main menu and click the Advanced Setup button. On the subsequent **EDIT AIRPORT SETUP** MENU click the Default (Unknown) Aircraft button (refer to *Subsection 3.4.1*).

### 5.3.6 Data Modes

#### Multiple Trips per Line Mode

The standard input file originating from air traffic control operational datasets contains one line of data for each aircraft movement (***Figure 40***). However, aggregated datasets, where one line of data relates to multiple movements are commonly used in the industry (e.g. in scheduling/travel booking applications). These datasets typically take the form of 'city pair', 'aircraft type' and 'no. of movements' for a given period of time (e.g. a year). An extract of an example dataset is shown in ***Figure 45***.

| DATE | TIME LOCAL | ORIGIN AIRPORT | DESTINATION AIRPORT | AIRCRAFT | Airline | Mvt_Nums | IATA_Org | IATA_Dst |
|---|---|---|---|---|---|---|---|---|
| 1/01/2011 | 01:00 | YNPE | YBCS | DH1 | Q6 | 298 | ABM | CNS |
| 1/01/2011 | 02:00 | YMAY | YSCB | SWM | FQ | 384 | ABX | CBR |
| 1/01/2011 | 03:00 | YMAY | YMML | SF3 | ZL | 914 | ABX | MEL |
| 1/01/2011 | 04:00 | YMAY | YSSY | DH3 | QF | 962 | ABX | SYD |
| 1/01/2011 | 05:00 | YMAY | YSSY | DH4 | QF | 387 | ABX | SYD |
| 1/01/2011 | 06:00 | YMAY | YSSY | E70 | DJ | 320 | ABX | SYD |
| 1/01/2011 | 07:00 | YMAY | YSSY | E90 | DJ | 396 | ABX | SYD |
| 1/01/2011 | 08:00 | YMAY | YSSY | SF3 | ZL | 1,308 | ABX | SYD |
| 1/01/2011 | 09:00 | YMAY | YSWG | SF3 | ZL | 6 | ABX | WGA |
| 1/01/2011 | 10:00 | YPAD | NZAA | 320 | NZ | 253 | ADL | AKL |
| 1/01/2011 | 11:00 | YPAD | NZAA | 763 | NZ | 6 | ADL | AKL |
| 1/01/2011 | 12:00 | YPAD | YBAS | 73H | QF | 365 | ADL | ASP |
| 1/01/2011 | 13:00 | YPAD | YMAV | 320 | TT | 171 | ADL | AVV |
| 1/01/2011 | 14:00 | YPAD | YBHI | SF3 | ZL | 740 | ADL | BHQ |
| 1/01/2011 | 15:00 | YPAD | YBRM | 73W | DJ | 31 | ADL | BME |

**Figure 45 Example of a Multiple Trips per Line data file**

When datasets of this form are being loaded the ☐ Multiple Trips per Line box, which is found under the **Data Mode** heading (section **[A]** in ***Figure 41***), must be checked. The program will add a **MvCnt** field to the **Fields to Import** list (**[F]** in ***Figure 41***) if it does not already exist. The **MvCnt** field in the dataset corresponds to the field containing the number of aircraft movements on any given line of data (e.g. the Mvt_Nums column in ***Figure 45***).

Once the file is loaded, the program functions and interface for all areas of the program will be exactly the same for the user as when using the program with standard format aircraft movement files.

#### Corporate Mode

When carrying out corporate reporting the format of the dataset used to compute the carbon footprint will be different to that used when computing aviation network carbon footprints. In this case the file will typically list the name or names of individuals who carried out particular journeys (see ***Chapter 9***).

When the movement file that is being loaded is a list of corporate passenger travel, specifying the number of passengers that travelled on each trip, the ☐ Corporate option, which is found under the **Data Mode** heading (section **[A]** in ***Figure 41***), must be checked. The program will add a new field to the **Required Fields** list called **PAX** that must then be set to its relevant field in the **Column Input File** list.

When data is loaded with the ☐ Corporate option selected, the **Queries & Reports** interface can then properly calculate the carbon breakdown when the **Corporate Footprinting** mode is active.

Selecting the ☐ Corporate checkbox options is a shortcut method for opening the **Additional Fields to Import** screen (*Figure 46*) and choosing the standard field **PAX** as an extra. For a breakdown of the Corporate Footprinting facilities refer to *Chapter 9*.

**Industry Mode**

This mode is used when the input file already contains known values. For example, if an airline is loading a dataset it is likely to already have actual data relating to fuel use, distance flown, number of seats and/or passengers. If this data is available, and is contained in the dataset in the right format, the program will accept, rather than compute, the value for any given operation. If there are missing entries in the dataset, the program will compute the values in the normal manner.

When carrying out network reporting the format of the dataset used to compute the carbon footprint will be different to that used when computing aviation network carbon footprints.

When t the file being loaded already contains data for distance, fuel, seats and passengers, the ☐ Industry option must be checked. The program will add the following fields to the **Fields to Import** if they do not already exist: **DISTANCE**, **FUEL**, **PAX** & **SEATS**. All unset fields in here will be set to their matching counterpart in the **Input Data Fields** list.

When data is loaded with the ☐ Industry option selected, the **Queries & Reports** interface will switch to this mode and the program will use the specified values contained in the aircraft movements file that is being loaded.

Selecting the ☐ Industry checkbox options is a shortcut method for opening the **Additional Fields to Import** screen (*Figure 46*) and choosing all of the standard fields: **DISTANCE**, **FUEL**, **PAX** & **SEATS** in the **Standard Field** section. For a breakdown of the Industry Mode footprinting facilities refer to *Chapter 9*.

### 5.3.7 Extra Fields

To enhance data reporting it is often necessary to breakdown movement and carbon data based on one of the standard Save Points that are available. For a complete list of the Save Points that are available refer to *Chapter 7*.

If it is necessary to break down the data based on one or more of the fields in the actual movement data file it is possible to have the program generate Save Points based on these fields. These fields are collectively known as **Extras**. Some examples of extra fields could include: Department or Section, Traveller Name, Cost Centre Code, Reason for Travel, Billable/Non Billable, Freight/Passenger. The ability to breakdown the data is only limited to the availability of the breakdown data.

There are two types of extras that can be imported into the program: predefined standard fields and all other fields. To identify fields that are to be imported as **Extras** click the Fields button and the **Additional Fields to Import** interface will be presented (see *Figure 46*).

**Standard fields** [1a] **&** [1b]

**Distance** – the actual trip distance
**Fuel** – the actual fuel used
**Seats** – the number of seats available on the aircraft
**PAX** – the number of actual passengers on the flight

**Existing Import File Fields** [2a] **&** [2b]

This list displays of all the fields currently available. The selection of other fields allows the program to create Save Points based on these fields.

To select a field to include as an extras simply double-click the item in either left list **[1a]** or **[2a]**. To deselect a field already set up as an extra simply double-click the relevant item in one of the lists on the right **[1b]** or **[2b]**. Alternatively, to add a field highlight the item in list **[1a]** or **[2a]** and click the button at **[3]**. To remove an item from one of the include lists **[1b]** or **[2b]** highlight the item and click the button at **[3]**. The button **[3]** caption will change depending upon which list was last clicked.

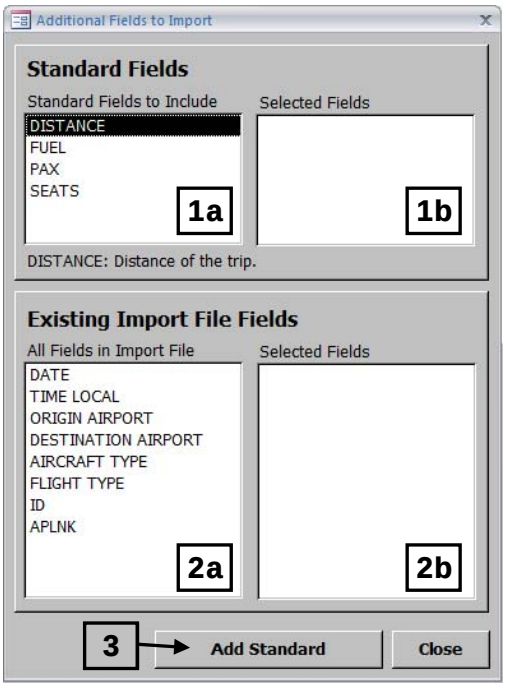



**Figure 46 Add/Remove Additional Fields**

If Extra fields have been selected it is necessary to check the option ☐ Add 'Extras' (section **[c]** in ***Figure 41***) otherwise the Extras will be ignored when the data is loaded. To ensure that Save Points based on each Extra field is generated the ☐ 'Extra' Save Points (section **[C]** also) option must also be checked.

If the ☐ 'Extra' Save Points option is not checked at load time it is still possible to generate the **Extra Save Points** by opening the **Save Point Builder** (***Section 7.5***), checking the ☐ Use Filter... option and then clicking the Fields button.

### 5.3.8 Integrity Checking

While the **Data Input & Pre-processing** interface provides great flexibility when it comes to data format and structure it must be noted that, for ease of use, data length integrity checking is postponed until all fields have been set up and the data loading process has begun.

To check data integrity before the data load begins, thus ensuring that the currently set fields in the preloaded data do not exceed their maximum field length size, click the Check button (area **[A]** in ***Figure 41***).

In the sample integrity check in ***Figure 47*** one line of preloaded data is in error and the error results show the summarised errors where the data exceeds the maximum field length allowed. The three fields listed in this example in ***Figure 47*** are: [ORIGIN AIRPORT], [DESTINATION AIRPORT] and [AIRCRAFT TYPE]. Beside each of these fields will be the maximum allowable size of the field and the number of data lines that exceed this limit.

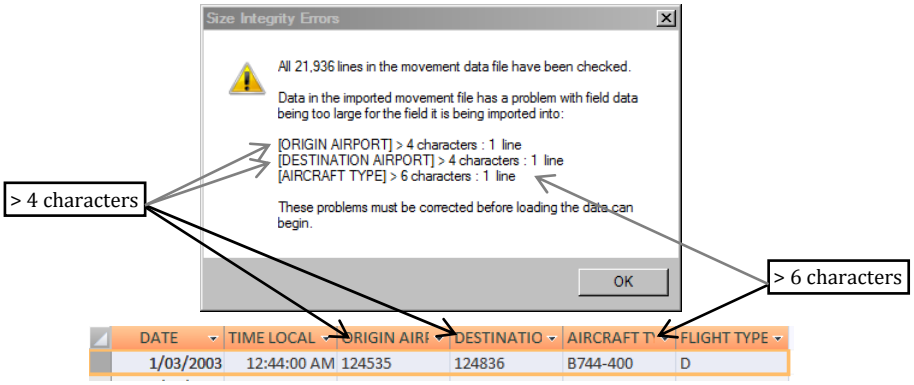

Size Integrity Errors
All 21,936 lines in the movement data file have been checked.
Data in the imported movement file has a problem with field data being too large for the field it is being imported into:
[ORIGIN AIRPORT] > 4 characters : 1 line
[DESTINATION AIRPORT] > 4 characters : 1 line
[AIRCRAFT TYPE] > 6 characters : 1 line
These problems must be corrected before loading the data can begin.
OK
> 4 characters
> 6 characters
DATE
TIME LOCAL
ORIGIN AIRF
DESTINATIO
AIRCRAFT TY
FLIGHT TYPE
1/03/2003
12:44:00 AM
124535
124836
B744-400
D

**Figure 47 Integrity Check Error Results and Sample Data in Error**

If errors are returned they should be fixed before the data load is started. Modify the actual data file to correct the problems listed and reload (click ) the file again to perform the preload process on the modified data and click the Check button to recheck the data changes. Alternatively, click on the button and select NO to open the preloaded data for editing. From the data sheet correct any problems and close the data sheet. Try rechecking the data by clicking the Check button. Repeat these processes until all problems have been fixed.

## 5.4 Vault Folder Selection

The selection of a Vault folder is mandatory whenever loading data, counting carbon or building Save Points is performed.

The **Vault Folder** list (**[B]** in ***Figure 41***) depicts standard Vault folders as plain yellow folders (**[1]** in ***Figure 48***) with no markings, however, when highlighted, the folder opens and shows a piece of paper inside (**[2]** in ***Figure 48***).

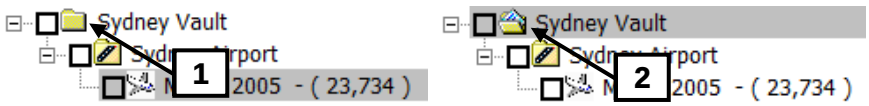



**Figure 48 Standard Folder Samples**
**(Unselected [1] & Selected [2])**

All actions performed will be applied to the selected folder. When a data load has been performed all airports added to the selected folder will appear immediately underneath it.

From the **Vault Folder** list (**[B]** in ***Figure 41***) scroll through until the desired standard yellow folder is located and highlight this folder. When a standard folder has been highlighted and all other options have been set correctly, the button to start the data load, Save Point build and/or carbon count will be enabled and the process can be started.

It is worthwhile noting that any carbon counting or Save Point building will always be performed on both new and existing movements in the folder that has been selected.

## 5.5 Load Options

There are a number of options related to the actual loading of data, however, the three main options discussed here are: ☐ Filter By Airport (immediately above the area **[c]** in ***Figure 41***), ☑ Add Airports and ☑ Add Movements (last two options are both inside the area **[c]** in ***Figure 41***).

### Filtering by Airports

The first option, ☑ Filter By Airport YSSY, YBBN, YMML, can be used to limit, or filter, which airports and, therefore, which movements are loaded. To limit the data load to a single airport first check the option and then enter in the ICAO code for the airport in the text box provided. Only this airport and its movements will be added. To filter multiple airports list each airport code sequentially separated by either a space or a comma.

### Adding Airports

When movement data is loaded, each movement will be associated with an airport. If the airport already exists, the program will automatically try to identify a related movement set – if this exists the new movements will be loaded into it. If a related movement set (e.g. the month of March 2008) cannot be found, it will be created first. This assumes the option to add movements is also set - refer below to the **Adding Movements** section.

If an airport cannot be found for a movement and the ☑ Add Airports option is checked, the airport entry will be created and movement loading will continue. If this option has not been checked, the airport will not be created and the movement will not be added. When unchecked, only movements for airports that already exist will be added.

Reducing the number of airports loaded can simplify reporting by avoiding clutter and by keeping the physical size of the Vault small, thus reducing load time and making it faster to work with. With this in mind it is often desirable to set up a Vault for a specific purpose and only load movements for existing airports in the Vault.

When dealing with a Vault with existing airports, this may be simpler than using the ☐ Filter By Airport option and specifying the desired airport codes particularly if they are not known or there are a large number of them. Alternatively, if only **Save Point** building or carbon counting is being performed this option and the ☑ Add Movements option should be turned off.

When checked the following options are available (area **[c]** in ***Figure 41*** underneath the ☑ Add Airports option):

☐ Add unknown

When loading movements and the Origin airport has not already been created in the Vault, this airport entry must be created. By default, airport that exist in the loaded airports will be created, however, if an airport does not exist in the loaded airports it, and all its movements, will be discarded.

When this option is checked, the program will automatically create corresponding vault airport entries for these unknown airports and then load movements under the relevant airport. It is important to note, however, that the carbon for these airport entries cannot be counted correctly as their location is unknown.

When left unchecked, movements from unknown airports will be ignored.

If using the Combined Arrivals and Departures data format and one airport is missing, only the known airport half of the movement will be

added.

Domestic only

When this option is checked, each movement airport is checked and if the base airport's initial prefix matches the ICAO code prefix entered in the text field here then that movement will be loaded. If the airports initial prefix does not match the prefix entered the movement will be ignored.

ICAO code prefix

For example, to include only Australian airports enter Y in the ICAO code prefix field.

### Adding Movements

To load movement data the Add Movements option must be checked (found inside the area **[c]** in *Figure 41*). If this option is not checked no movements will be loaded.

If only **Save Point** building or carbon counting is being performed this option and the Add Airports option should be turned off.

When the Add Movements option is checked the following sub options become available:

Delete existing

Check this to delete existing movements.

When imported, movements are categorised into sets under the month, the year or a specific name. (see In Year Month Name )

Even if there is a single movement to be added to a movement set all existing movements will be deleted from this movement set. Check this option only if all movements are to be replaced.

If adding movements to existing movement sets do not check this option.

Add 'Extras'

If any fields have been specified as Extras in the data file setup section checking this option will cause the Extra fields to be imported (see *Subsection 5.3.7*).

'Extra' Save Points

Checking this will cause basic Save Points to be created for any Extra fields. If movements for Extras fields already exist in a movement set, Save Points for the existing extras will also be generated as well as any new ones added.

The Save Points created will break down by category the actual contents of the data in these fields.

In Year Month Name

All movements are saved in movement sets. One or more movement sets can be saved under an Airport. This option controls which movement set each movement is saved into. If the expected movement set does not exist it will be created.

**Year**: The name will be based on a four digit representation for the year of the movement, e.g. 1990, 2010.

**Month**: The name will be based on a representation of the month name and then followed by the year of the

movement, e.g. April 2009, May 2010.

**Name**: Whatever is entered in the text box will be used for the name of the movement set.

## 5.6 Building Save Points

Check the ☑ Build Save Points option (**[D]** in ***Figure 41***) to create Save Points as part of the data loading process. While the number of selected Save Points is displayed it is advisable to confirm that the desired Save Points are selected by pressing the **Select** button next to this option. When **clicked** the **Save Points to Build** interface will open (***Figure 49***).

Simply clicking an item in the **Save Point Types To Build** list will deselect any others that were previously selected. If you wish to select more than one Save Point hold down the Ctrl key and click the desired Save Points. When the correct Save Points have been highlighted, click the **Close** button to return to the **Data Input and Pre-processing** screen.

As with carbon counting, data does not have be loaded at the same time as Save Points are built. This option can be run on its own without any of the other options.

If one or more of the selected Save Points require further information from the user this will be prompted for when the Save Point building process is first started.

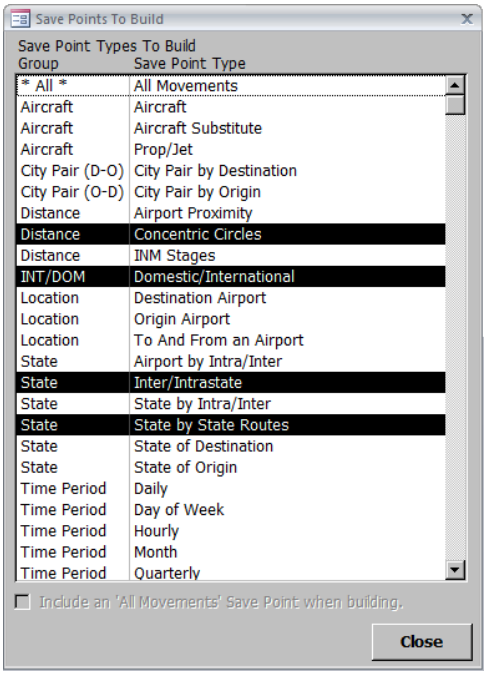



**Figure 49 Save Points to Build**

## 5.7 Counting Carbon

When movement data has been loaded there are a number of data related tasks that must be performed in order to display any carbon related queries or reports. To calculate the carbon for each movement the program must first calculate the airport-to-airport movement distance, identify the aircraft fuel burn characteristics and then compute the carbon produced.

To initiate a carbon count, check the ☑ Count Carbon option (**[E]** in ***Figure 41***). When this option is checked three sub options become available.

When counting carbon the user may specify the default load factor to use Load Factor 100, whether to apply a Radiative Forcing Index (R.F.I.) R.F.I. 1 and whether to include the Great Circle Distance correction factor G.C.D. ☑ (see ***Section 13.2***).

As discussed in the introduction to this section, if two or more movement files must be loaded, one after the other, it is best to delay carbon counting until the last movement file has been loaded and then check this option as this may greatly reduce the time to process all movements during the previous data loads.

It is worth noting that data does not have be loaded at the same time as counting carbon as this option can be run on its own without selecting any of the other options

# Part III

# Filtering Tools

# Chapter 6

# Network Filter Tool

## 6.1 Introduction

The Network Filter tool is used by various parts of the Carbon Counter to work with or display user selected filtered movement sets. By using the tool it is possible to select specific airports and their movements. Save Point building, carbon counting, analysis and reports all use the tool to determine which movements to work with. The Data Vault also uses the tool to determine which movements to display. An understanding of how the tool works is essential.

The tool has two parts which are shown in ***Figure 50*** and highlighted with blue dots and red dashes.

- The first half at the left of the screen (blue dotted area) and identified by the Pre-Filter, Airports and Movement Filter Sections is used to select which airport movements to include in a filter.
- The second part is the Saved Filters area to the right (red dashed area) and is used to build a filter, activate one or edit an existing pre-saved filter.

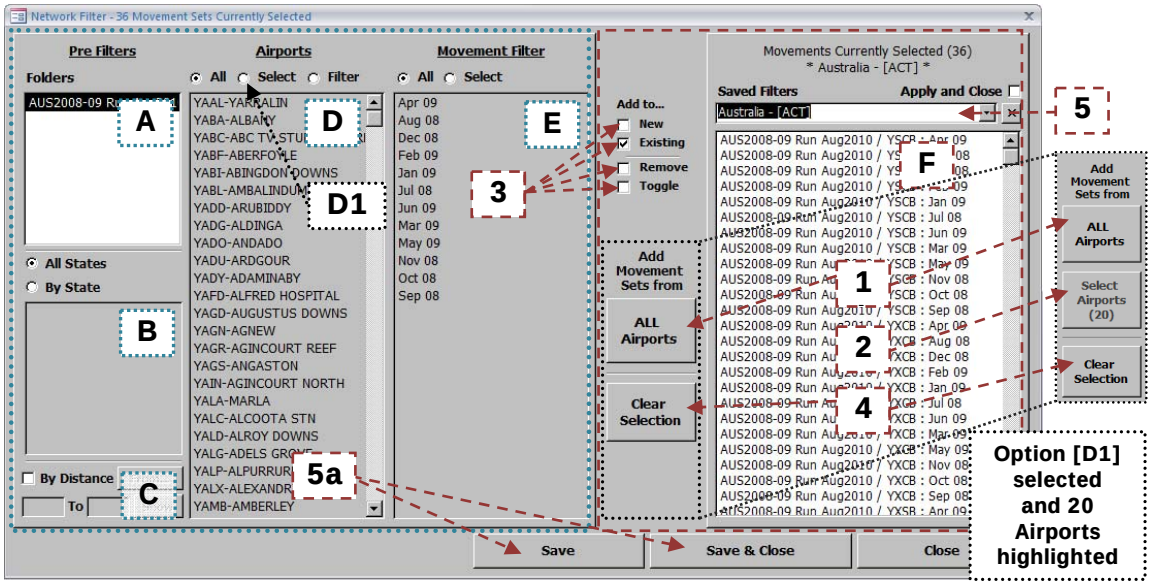



**Figure 50 Network Filter tool**

## 6.2 Step One – Airport Movement Selection

Building an airport movement filter involves using the options in the first part (blue dotted area) to select airport movements and then using either the **All Airport**s **[1]** or **Select Airports [2]** button in ***Figure 50*** to add, remove or toggle these movements.

There are five steps or sections to the first part of the screen (blue dotted area), however, only the first of these steps **[A]** is mandatory.

- **[A] By Folder Option**: The first step in selecting airport movements is to select a folder from the **Folders** list **[A]** in the **Pre Filters** Section. This list shows all the folders that

are loaded into the current vault. Folder selection must be done first otherwise no other selections can be made. Once a folder has been selected from the list the relevant states, airports and movements can be displayed.

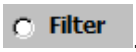
There are four remaining Sections to this part of the interface. Any combination of the remaining four options is possible.

- **[B] By State Option**: If the **All States** option is selected the State list is turned off and all airports (all states) are available.

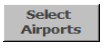
Selecting the **By State** option will enable and populate the **State** list **[B]** with all the states as defined in the Airports file and then loaded into the Vault for each airport entry that is available in the selected folder **[A]**. Only one state can be selected at a time. When a state is selected only airports in that state will be displayed. Depending upon the remaining options only Airports from the selected state and their Movements will be included in the Airport and Movements lists.

- **[C] By Distance Option:** After checking the **By Distance** checkbox option and an airport is currently active, the **From** and **To** fields will be enabled along with the **Show** button. The **Airports** list **[D]** will be populated with airports that are in the distance range from the currently active airport. If no airport is currently active one must be selected before a **By Distance** filter can be enabled.

Enter the distance range in the **From** and **To** fields and click the **Show** button to activate the **By Distance** option.

- **[D] Airports Options**: The **Airports** list in this section will change depending upon the Airport options that are selected. When the desired options have been set click either the or button to included the airport movements to the current filter. There are three ways to select airports to be included in a filter. Under the Airports heading there are a set of radio buttons: , and  .

- – All airports will be included. The **Airports** list **[D]** is greyed out.
  The button **[1]** will include all airports listed.
  The  button **[2]** is not visible.

- **[D1]** – When this option is checked the **Airports** list **[D]** is enabled allowing items in the list be selected. The button **[2]** becomes visible and will be enabled as soon as at least one airport from the **Airports** list has been selected. This is represented by the black dotted section shown in ***Figure 50*** where 20 airports have been selected.
  The button **[1]** will include all airports listed whether they are selected or not.
  The  button **[2]** will cause movements for only the selected (highlighted) airports to be added to the current filter. This button is only visible when the airport option is checked and at least one airport has been selected. To select more than one rport from the **Airports** list hold the Control key down and click the desired airports. No filter is applied to the airports list.

- – When this option is chosen a filter field underneath these options is displayed and the **Airports** list **[D]** is enabled. Enter all or part of an airport code or airport name in this field and the **Airports** list will be limited by the text entered. To filter

by several pieces of text (or airport codes) separate each piece of text with a comma, e.g: YBBN, YSSY, YCSB.

The All button [1] will include movements for all of the filtered airports whether selected or not.

The Select Airports button [2] will include movements for only those airports in the filtered **Aiports** list that have been selected (highlighted).

- **[E] Movement Filter Options**: There are two ways for determining which movements are included in a filter. When the desired movement options have been set click either the All or Select Airports button to include the airport movements to the current filter. Under the Movement Filter heading there are two selectable radio buttons: All and Select.

- All – The Movements list [E] will be greyed out, items cannot be selected and no filters are applied to the list.

  The All button [1] will include all movements for all airports.

  The Select Airports button [2] will include all movements for the selected airports. Note that this button is only available when either the **Airports Select** or **Airports Filter** option (see [D] above) is checked and at least one item from the **Airports** list (also [D]) has been selected.

- Select – This enables the Movements list [E] and allows the user to click on one or more airport movements to select them. To select more than one movement hold the Control key down and click the desired movements.

  The All button [1] will include the selected movements only for all airports.

  The Select Airports button [2] will only include the selected movements; however, only those airports that are selected will have their movements included. This option is only visible when the **Airports Select** or **Airports Filter** option (see [D] above) is checked and at least one item from the **Airports** list (also [D]) has been selected.

## 6.3 Step Two – Building, Editing, Saving and Activating Filters

Once airport movements have been set up in the first part of the screen these movements can be added, removed from or have their state toggled in an existing filter. Alternatively they can be used to form a new filter.

When building a filter, it is possible to make a selection, add the listed movements to the filter and then repeat this procedure until the current filter contains all the desired airport movements. For most filters it is enough to follow this procedure, however, the interface is flexible enough to provide the ability to not only add movements to the current filter, but remove or even toggle the state of a movement based on its current state. These options can be seen at ***Figure 51***.

### Action To Take Options: Add/Remove/Toggle Checkboxes

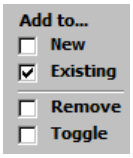



**Figure 51 Action To Take Options**

Depending upon the checkboxes pointed to in **[3]** the All **[1]** and Select Airports **[2]** buttons will have different effects and the title above these two buttons changes to reflect this. Changing which checkbox is ticked affects the actions of these buttons as follows:

- New Existing movements will be cleared every time one of the buttons is clicked. The relevant airport movements will then be added to the blank filter. This has the effect of always creating a new filter every time movements are added and eliminates the need to click the Clear button **[4]** every time movements are added.
- Existing This is the default action. Every time one of the buttons is clicked the relevant airport movements will be added if they have not already been added previously.
- Remove Every time one of the buttons is clicked the relevant airport movements will be removed from the filter if they were added previously. If they do not exist in the current filter they are ignored.
- Toggle Every time one of the buttons is clicked the relevant airport movements will be removed from the filter if they were added previously. If they do not exist in the current filter they will be added. In effect, their state in the current filter will be toggled, or flipped.

### Action To Take Options: All Airports & Select Airports Buttons

Adding, removing or toggling movements from the current filter will be reflected in the **Currently Selected Movements** list **[F]** *Figure 50*.

Depending upon the setting of the action to take option (pointed to by **[3]** in *Figure 50* and shown close up in *Figure 51*) the **Network Filter Tool** (*Figure 50*) action buttons All **[1]** and Select Airports **[2]** will have different effects and can be described as follows:

- All **[1]** Movements for *** all airports *** listed are added, removed or toggled.
- If the Movements Filter **[E]** radio button All is marked, all movements for ALL airports will be affected.
- If the Movements Filter **[E]** radio button Select is marked, only the highlighted movements for ALL airports will be affected. In essence all airports are included.
- Select Airports **[2]** Movements for only the *** selected airports *** listed are added, removed or toggled. This button is visible when either the airport section **[D]** filter option Select or Filter is checked and at least one item in the **Airports** list **[D]** has been highlighted, otherwise the button is not visible.
- If the Movements Filter **[E]** radio button All is marked all movements for only the Highlighted (or selected) airports will be affected.

- If the Movements Filter **[E]** radio button ◉ Select is marked only the highlighted movements for the highlighted (or selected) airports will be affected. The difference is that only the highlighted airports are included using this button.

The process of adding movements to the current filter can be repeated until all of the desired movements have been added, removed or toggled.

### Filter Management

The content of the current filter is displayed in the **Currently Selected Movements** list **[F]**. To clear currently selected airport movements click the Clear button **[4]**.

To restore one of the save filters and make it active, select its name from the dropdown list at **[5]**. This will load the saved airport movement filter into the **Currently Selected Movements** list **[F]** and these movements are immediately available for use.

### Saving a Filter and Closing

When satisfied with the movements currently selected, these movements can be saved under a user assigned name. The saved name will be stored in the **Saved Filters** list **[5]** and can be restored at a later stage. Click the Save Filter button **[5a]** and give the currently selected movements a name in the subsequent dialog. If the tool is to be closed after saving a filter, it may be more convenient to click the Save Filter & Close button **[5a]** instead as the tool is then closed immediately after saving and the program will return to the calling screen.

Unless the purpose for the current filter is short lived and will not be used again, giving a filter a name is highly recommended. The save filter name is used by other parts of the Carbon Counter to display to the user which movements are currently being worked on. When no name is supplied the program can only list the number of movements in the current filter.

If one of the saved filters needs to be deleted, select the filter to be deleted using the dropdown list. Once the filter is active click the ✕ button next to the dropdown list **[5]** and you will be prompted with the Delete Airport Selection dialog box. Click **Yes** to delete the filter.

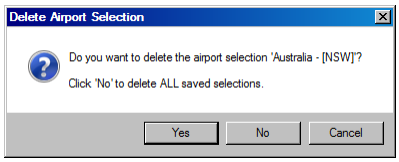

Delete Airport Selection
Do you want to delete the airport selection 'Australia - [NSW]'?
Click 'No' to delete ALL saved selections.
Yes
No
Cancel

**Figure 52 Delete Save Filter dialog**

If you wish to delete ALL of the saved filters click the **No** button and confirm the deletion in the subsequent dialog. Be aware that this procedure will delete all filters and cannot be undone. Any changes (restoring a saved filter, adding, removing or toggling) are made active immediately.

Upon closing, the program will return to the screen which called the **Network Filter Tool** and the movements that were displayed, or affected, by the calling screen will be updated to those movements last displayed in the **Currently Selected Movements** list **[F]** of the **Network Filter Tool** upon its closing.

# Chapter 7

# Save Points

## 7.1 Introduction

When analysing movement data, it is often helpful and/or necessary to work with the data in subsets. Once data has been grouped into subsets, comparisons can readily be made between them. For example, it is possible to create a movement file with just international movements and a second one with domestic movements and then use these to generate information and reports cross-comparing the two different sectors.

The program incorporates customised filtering tools - termed **Save Points** - which enable the user to rapidly generate and work with data subsets inside the program. Throughout this Manual, **Save Point Groups** refer to the type of filtered subsets as shown in ***Figure 55*** while **Save Points** refer to the individual entries within these groups.

## 7.2 The Concept of 'Save Points'

Using Save Points provides a way of quickly filtering data from within the program without the need to use external spreadsheet or database tools. In comparison to other methods of data filtering they are extremely quick and simple to set up.

The TNIP Carbon Counter has been designed to use Save Points in many different parts of the program. They can be used to filter movements that are displayed in various movement, aircraft and airport listings as well as used in the TNIP Carbon Counter carbon reporting section to compile filtered carbon charts and graphs. Standardised reports, such as the **Destination Carbon League** and the **Aircraft Carbon League** reports (see ***Section Part IV11.5.1***) can also be filtered by Save Points that have been created. Using Save Points, filtered movement data, along with any calculated metric, can be exported for use in external programs.

When analysing the loaded data, Save Points can be used to drill down into the data to selectively identify and work with filtered aircraft movement datasets based on movement variables such as time, aircraft type and destination distance. Drilling down into the data will result in successive filters being applied until the desired granularity has been achieved.

## 7.3 Setting up 'Save Points'

Save points can be set up via the **Save Point Builder** interface (see ***Section 5.6***) and provide a way to automate the running of predefined filters. The key strength of the Builder lies in the rapid development of large numbers of Save Points. If more granularity is desired for comparisons, these automatically generated Save Points can be manipulated via boolean (i.e and/or) type operations.

The other key strength of the Builder is that one or more types of Save Points can be created automatically for a single movement file, or if desired, for any number or for all movement files that are saved in the Vault.

## 7.4 Save Points Management

The management of Save Points at an individual airport movement level, such as deletion, renaming, copying and moving can all be done via a single interface.

From the Vault (***Figure 26***), highlight a movement set, activate it, click Yes to open the **Active Movements** interface and then click the Save Points button at the bottom of this window. Note that to edit the Save Points for a particular movement set they must be both active and highlighted otherwise this button will be greyed out.

Alternatively, from the Carbon Counter interface (e.g. ***Figure 90***) the Save Points interface can be accessed by clicking the Save Points button at the bottom of the screen.

A further way of creating Save Points is via the **Data Input & Preprocessing** interface (refer ***Section 5.6***)

When the **Save Points** interface is brought up, the user will see a screen similar to the screenshot in ***Figure 53***. The number and names of Save Points in the Save Points list may vary as will the details in the title bar which is modified to display the number of movements in the current search filter or Save Point.

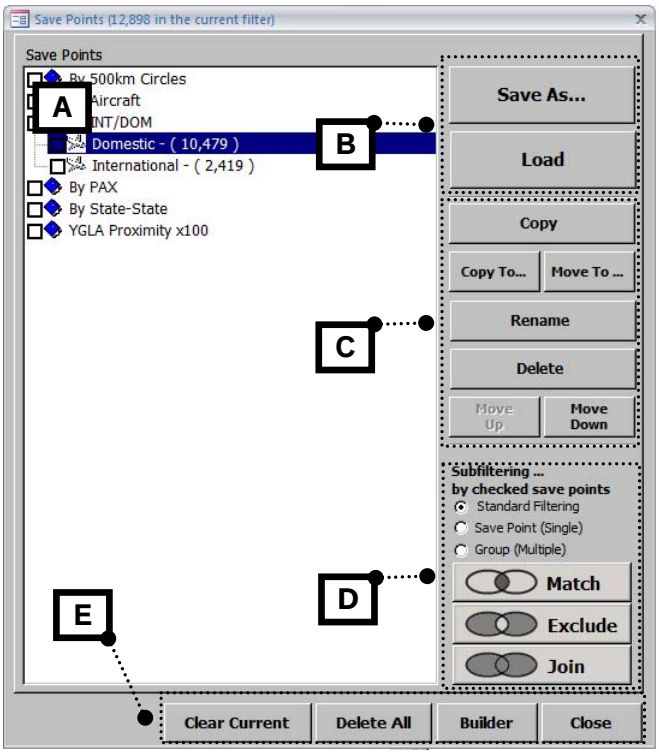



**Figure 53 Save Points management interface**

While there are a number of options on this interface, it is quite simple to use.

The Save Points list on the left of the screen **[A]** shows all of the currently saved Save Points. A simple tree style structure is used to group the Save Points together. Each group is designated by a picture of a blue book. Inside each group there are any number of Save Points which are themselves designated by the picture of an aircraft similar to that used by movement sets in the Vault.

Depending on what is selected in the Save Points list certain buttons will be enabled or disabled. These buttons can be viewed in four groups. Three group functions - can be seen on the right of

the Save Points list; (i) Saving and Loading **[B]**; (ii) Copy, Rename, Delete and Move **[C]**; and (iii) Subfiltering **[D]**. There is another set of buttons on the bottom of the interface **[E]**. The functions and state of each button by group is as follows:

**Saving and Loading Group Functions [B]**

- Save As... - Save the currently active filter or Save Point. The **Save Filter As**... dialog will allow the user to change either the group or Save Point name. When these are correct click the **Save** button to complete the process.
- Load - Select one of the Save Points in the **Save Points** list and then click this button. This will cause the selected Save Point to be loaded and made active. When a group is selected (blue book icon) the button will be disabled.

**Copy, Rename, Delete and Move Group Functions [C]**

- Copy - This makes an exact copy of the selected Save Point in the list. After confirming the operation, a copy of the Save Point will be made in the same group as the original. The new name of the copy will be prefixed with the text **Copy of** and followed by the original name.
  If the currently selected item in the Save Point list is a group entry (blue book icon), the user will be asked if they want to make a copy of all the Save Points in the group rather than a single Save Point.
- Copy To... - This button creates a copy of the selected Save Point, however, unlike the Copy button, Copy To... allows the user to specify the group where the copy will be placed. After confirming the procedure the user will be presented with the **Destination Save Point Group** dialog box. When the name of the new group is correct click the **OK** button and the copy will be created.
  Copy To... does not work with Save Point Groups.
- Move To ... - This button moves rather than copies the currently selected Save Point to a new group. After confirming the procedure the user is again presented with the **Destination Save Point Group** dialog box. When the name of the new group is correct click the **OK** button and the Save Point will be moved to the new group. Move To ... does not work with Save Point groups.
- Rename - This button changes the name of the currently selected Save Point or Save Point group. After selecting this option the user will be prompted with a dialog box allowing the user to specify the new name of the Save Point or Save Point group. When the name is correct click the **OK** button to complete the rename procedure.
- Delete - This button is used to delete a Save Point or Save Point group. When a group is selected all Save Points in that group will also be deleted. After confirming the operation the select item and any related ones will be permanently deleted.
- Move Up - Save points in the list are, depending upon how they were created, ordered either by the name of the Save Point or the order in which they were created. If the user wishes to change the order in which the items are displayed the Move Up button can be

used to shift the item above its current position. Note that the top item in the list cannot be moved up any further, when the item at the top of the list is selected this button is disabled.

- Move Down - Similar to the Move Up button, this button changes the display order of the Save Points in the list by moving the currently selected item below the next item in the list. Note that the bottom item in the list cannot be moved down any further. When the bottom item is selected, this button is disabled.

**Subfiltering Group Functions [D]**

Subfiltering is a way of combining the details from two or more Save Points based on one of three different types of subfiltering operations: Match, Join and Exclude. The end result of this subfilter process is to generate new Save Points.

To perform a subfilter operation you must check the checkbox next to the Save Point in the *Save Points* list to indicate which Save Points are to be worked with.

It may be useful to think of each of the subfilter operations in terms of the boolean operations: AND, OR and NOT.

- Standard Filtering – These sub filters requires that all of the checked Save Points belong to the same Save Point group. The boolean operations below will apply to all entries in the **Save Points** list that have been checked.

Match This can be thought of as an AND style boolean operation on the checked Save Points. Only movements that are common to all checked Save Points will be included in the results of this operation. Each movement in the result will only be included once.
For example: If you had two Save Points: Domestic and Jets, you could use the Match button to get all Domestic movements using Jets.

Join This operation can be thought of as an OR style boolean operation on the checked Save Points. Every movement in all of the checked Save Points will be incorporated into the results of this operation. Each movement in the result will only be included once.
For example: If you had two Save Points with movements going to Melbourne and Brisbane airports you could use the Join operation to combine the two to get a Save Point of all movements going to either Melbourne or Brisbane.

Exclude This operation can be thought of as a NOT style boolean operation on the checked Save Points. Only movements not common to all (or not in all) of the checked Save Points will be included in the results.
For example: You could take the Save Points created in the Join operation above and another Save Point with All movements and use the Not operation to get all the movements not going to Melbourne or Brisbane. This could take quite a while to selectively build up via the Search function!
You could then take the results of the above operation and the Save Point of all jets and Not them together and you would then have all the non jet operations flying to all places except Melbourne and Brisbane.

- Save Point (Single) – This sub filter allows for a single reference Save Point to be identified and then have all boolean operations applied against the reference Save Point.

To select the reference Save Point, first highlight the Save Point to be used for the reference and then click the Save Point (Single) option. Then click the **SET** button that only appears next to this option when it is selected.

Upon setting the reference Save Point the display will change so that the name of the reference Save Point and the group it belongs to will be displayed in blue immediately above these options.

If the current reference Save Point is already selected in the **Save Points** list, boolean operation buttons will be greyed out and the **SET** button has no effect. Picking another item in the Save Points list will enable the boolean operation buttons.

If the reference Save Point has already been selected and the currently selected Save Point is different and, either the option is turned on again, or the **SET** button is pressed, a dialog box (shown in ***Figure 54***) will advise the user of the current Save Point and the new Save Point it will be set to. Click **Yes** to change the reference to the new Save Point, otherwise click **No** to leave the reference Save Point unchanged.

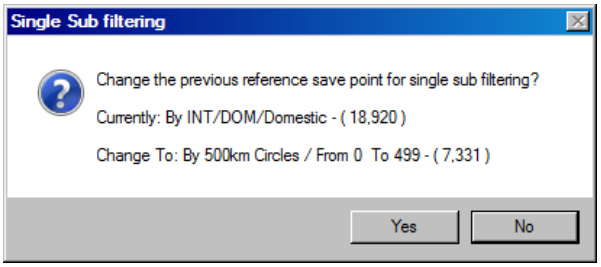

Single Sub filtering
Change the previous reference save point for single sub filtering?
Currently: By INT/DOM/Domestic - ( 18,920 )
Change To: By 500km Circles / From 0 To 499 - ( 7,331 )
Yes
No

**Figure 54 Change Single Sub filtering dialog**

When this sub filtering type has been selected the boolean operation buttons will change and the Venn diagrams displayed on each will signify the reference Save Point (blue circle = blue writing) and how each operation will be applied to the reference.

Match All selected (checked) Save Points in the Save Points list will be compared against the reference Save Point. Only those movements which are common to both the reference and selected (checked) Save Points will be included.

Exclude All selected (check) Save Points in the Save Points list will be compared against the reference Save Point. Only those movements which are not common to the reference and the checked Save Points will be included. Matched movements are excluded.

Join All movements in the reference and all movements in the selected Save Point list will be included.

## 7.5 The Builder Interface

The Builder was created as a way to simplify the creation of Save Points and encourage their use for data analysis. To assist this, access to the Builder has been provided via the Save Point management screen which, in turn, can be accessed by clicking on the button titled *Save Points* from the Data Vault and Active Movements screens. At the bottom of the Save Points management screen the user then clicks the Builder button to display the Builder interface as shown in ***Figure 56***. It is also possible to access the Builder from the Data Vault interface (***Figure 26***) directly by clicking on the **Builder** button.

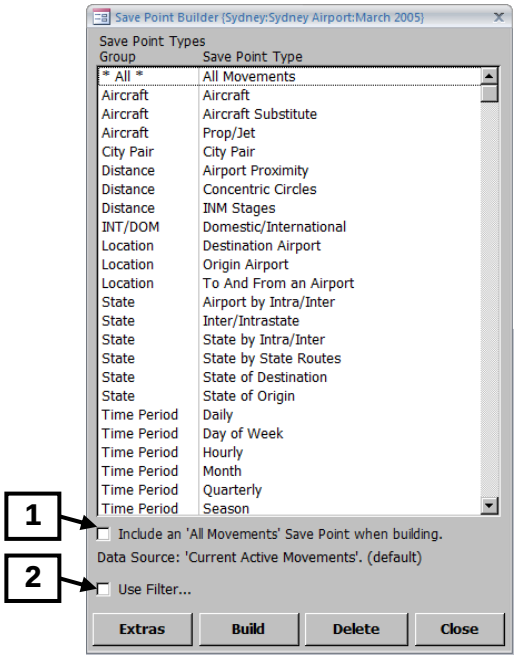



**Figure 55 Save Point Builder interface**

The Builder interface presents the user with a list of predefined Save Points which can be built. Save Point creation is a simple matter of selecting one or more of the **Save Point types** in the list and clicking on the **Build** button.

Depending upon the **Save Point types** selected the user may, or may not, be prompted to answer one or more questions specifying various options for building the Save Points. For each Save Point type that is selected there may be any number of actual Save Points created. To separate and group the Save Points into a manageable structure the Save Points in each type will be grouped into special Save Point folders.

When Save Points are used to specify the data used in a report these names will, depending on the makeup of the report, be displayed at the line item level, header or report key. A special Save Point which actually includes all movements can be created and, when used in reports, will identify that the report is made up of all movements rather than a sub set by using the name '* All Movements *'. To create a special '* All Movements *' Save Point for each group of Save Points in the Save Point types, select the 'Include an 'All Movements' Save Point when building' checkbox at **[1]**.

### 7.5.1 Current Movements vs Vault Movements

By default, the Builder will be limited to, and only create Save Points for, the currently active movements. It is possible to have the Builder build the selected Save Point types and, when finished, automatically activate another movement set and build the same set of Save Point types for the newly activated movements. This process of automatically activating and building Save Points can be performed on any or all of the movement sets which exist in the current Vault.

To switch from using only the currently active movements to using one or more movement sets in the Vault select the **Use Filter...** box **[2]**. When this option is selected the **Filter** button will become visible (see ***Figure 56***) which allows the user to select which Vault movements (***Chapter 6***) will automatically be activated and have Save Points created for them.

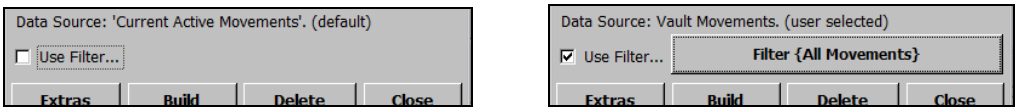



**Figure 56 Building in the Vault by checking the Use other data... checkbox.**

## 7.6 Builder Save Point Types

A number of Save Point types can be created. The following list of Save Point types is intended to provide a quick guide only. To understand what is created by each item in the list it may be useful for the user to create each Save Point Type and examine the results in order to understand how a particular Save Point type can be used. By running each Save Point the user will also learn which Save Point groups are created for each Save Point type. Becoming familiar with the Save Point groups will make recognition and selection of them easier.

### 7.6.1 * All * Group

**Figure 57 All Group Save Point**

- **All Movements** – Only 1 Save Point will be created when this Save Point type is built. The single Save Point created will include all movements in the movement set for which it is created. If 23,000 movements exist one Save Point will created with 23,000 movements in it.
  Save Point group:* All *

### 7.6.2 Aircraft Group

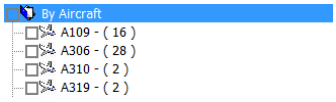



**Figure 58 By Aircraft Save Point**

- **Aircraft** - When selected a separate Save Point will be created for each type of aircraft named in the movement set. If the movement set has 23,000 movements but there are only 100 different types of aircraft making up the 23,000 movements then 100 Save Points will be created.
  Save Point group: Aircraft

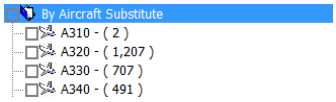



**Figure 59 By Aircraft Substitute Save Point**

- **Aircraft Substitute** – When this Save Point type is selected a separate Save Point will be created for each aircraft substitute used in the movement set. If the movement set has 23,000 movements made up from 100 different types of aircraft which have been substituted into 15 Groups then only 15 Save Points will be created – one for each aircraft substitute used.
  Save Point group: Aircraft Substitute

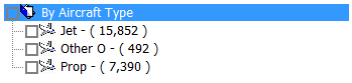



**Figure 60 By Prop/Jet Save Point**

- **Prop/Jet** – this will build Save Points based on the type of aircraft used. So long as they exist in the movement set, typically, this will result in a Jet, Prop or Other Save Point.
  Save Point group: Aircraft Type

### 7.6.3 City Pair Group

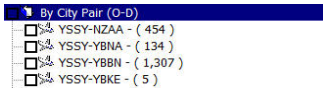



**Figure 61 By Prop/Jet Save Point**

- **City Pair (O-D)** – this will build Save Points based on the origin airport code then followed by the destination airport code and separated by a hyphen. This is the general way

movements are listed.
Save Point group: By City Pair (O-D)

- **City Pair (D-O)** – this will build Save Points based on the destination airport code then the origin airport code and separated by a hyphen. Generally, when using city pair format, the pair order is usually the opposite way *(refer to **City Pair (O-D)** above)*. This Save Point exists so that movements can be easily grouped by destinations rather than origins.
Save Point group: By City Pair (D-O)

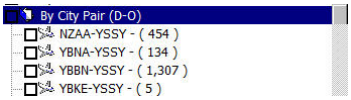
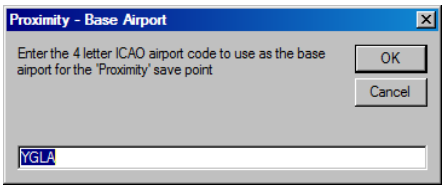


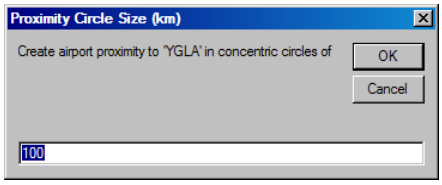

**Figure 62 By Prop/Jet Save Point**

### 7.6.4 Distance Group

- **Airport Proximity** – this Save Point allows the user to generate a filtered dataset that contains all the airports within a user selected distance band from a given airport (the base airport). The Save Point also computes the amount of fuel that is uplifted in total from all the airports captured in any band. The relevant interfaces are shown in ***Figure 63***.


Proximity - Base Airport
Enter the 4 letter ICAO airport code to use as the base airport for the 'Proximity' save point
OK
Cancel
YGLA

**Base (Reference) Airport dialog**




**Banding Size dialog**

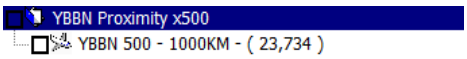



**Figure 63 By Proximity Save Point**

This Save Point differs from the Concentric Circles Save Point discussed next in that the Airport Proximity Save Point selects **all** airports within a certain distance of a selected airport (using data in the Airports file) rather than making selections based on aircraft movements (using data from an aircraft movement file).

This Save Point was introduced to enable the user to compute the amount of fuel notionally uplifted within a certain distance of any given location (e.g. a small scale biofuel plant (which can be entered into the Airports file as a notional airport).

Save Point group: *{Reference AP}* Proximity x*{Band}*

- **Concentric Circles** – this Save Point lets the user create multiple Save Points based on the trip distance for each movement based on the distance of the arrival/departure airport from any user selected airport. By default the distance covered for each Save Point is 500 kms, however, it is possible to build these concentric circles from anywhere between 1 to 15,000 plus kilometres.

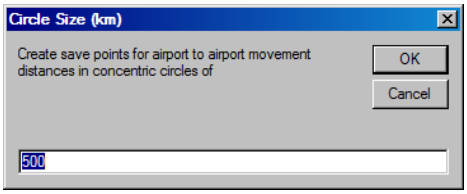
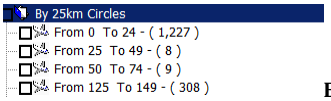



**Figure 64 Concentric Circles dialog**

Each time this Save Point type is built the user will be prompted to either accept the default 500 km concentric circles or enter a different value. This value is only asked once, therefore, if iteratively building Save Points in the Vault

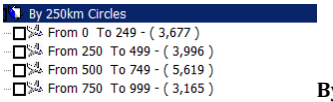



**By 25km**

all subsequent 'Concentric Circle' Vault movement Save Points will be built using the initial concentric circle size entered.

If the user wishes to create variable distance concentric circle Save Points this can be achieved by initially creating a number of different distance concentric circle Save Points and subsequently using the subfiltering features (Match, Join and Exclude) on the Save Point management interface (see ***Section*** 7.4) to combine the relevant Save Points.

Save point group: By *{999}* km Circles – where {999} is the distance in km used in the Concentric Size dialog box.




**By 250km**

**By 500kms**

**Figure 65 Concentric Circles Save Points**

- **INM Stages** – Use this Save Point type to create concentric circles based on the INM stage length of each flight. Depending upon the movements loaded there can be up to 7 Save Points created – 1 for each stage.
  Save Point group: By Stage

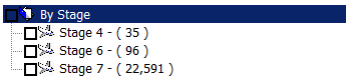



**Figure 66 Stages Save Point**

### 7.6.5 INT/DOM Group

- Domestic/International – Each loaded movement is allocated to either the Domestic or International category based on the information entered in the 'Domestic ICAO Airport Code Prefixes Used' field in the Edit Airport Setup interface. All domestic movements will be put in the Domestic Save Point and all international will be assigned to the International Save Point. Unknown movements will be included in the domestic Save Point.
  Save Point group: INT/DOM

### 7.6.6 Location Group

- **Destination Airport** – Creates a Save Point for each departure destination in the active movements where the name of the Save Point is given the name of the airport (as defined in the loaded airports) as shown in **Figure 67**. When the destination is unknown, and not in the loaded airports, the Save Point name will be made up of the actual airport code used in the movement. All movements include in this group of Save Points will be departures only.
  Save Point group: By Dest Airport

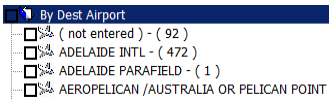



**Figure 67 Assessment Points Save Points**

- **Origin Airport** – Creates a Save Point for the origin airport of each arrival in the active movements where the name of the Save Point is given the name of the airport (as defined in the loaded airports) as shown in ***Figure 68***. When the origin is unknown, and not in the loaded airports, the Save Point name will be made up of the actual

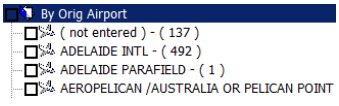
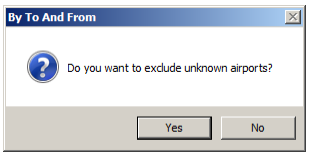



**Figure 68 Origin Airport Save Points**

airport code used in the movement. All movements included in this group of Save Points will be arrivals only.
Save Point group: By Orig Airport

- **To And From an Airport** – Creates a Save Point for each arrival origin and departure destination in the active movements. The name of the Save Point is given the name of the airport (as defined in the loaded airports) as shown in ***Figure 69***. Initially, when this Save Point is built the user will be asked if unknown airports are to be included when building Save Points. For known airports the Save Point name will be the same as it appears in the defined airports. Save Point names for airports not loaded will be made up of the actual airport code used in the movement.
  Save Point group: By To and From



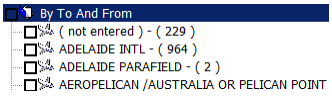




**Figure 69 To and From Save Points**

### 7.6.7 State Group

Each state type Save Point will derive the state of an airport, and consequently its state classification, from the details loaded from the Airports file. A description of the state classifications is as follows:

**International**: The first character in an ICAO airport code is used to determine the country that an airport belongs to. When movements are loaded those that do not match the domestic airport prefix will be flagged as either domestic or international.

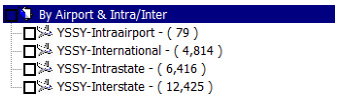
**Intraairport**: Movements are considered **Intraairport** when the origin and destination is the same. These would represent circuit training or where the aircraft returned to its origin airport.

If a movement is neither **International** or **Intraairport** it will be looked up to determine what state it belongs to.

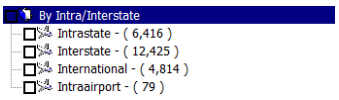
**Intrastate**: When the state of both the origin and the destination are the same a movement will be classed as Intrastate.

**Interstate**: For a domestic flight, when the state of the origin is different to the state of the destination the movement will be classed as Interstate.

- **Airport by Intra/Inter** – This will produce up to four Save Points and has two parts. The first part will be based on the home **airport code** for each movement (same for all movements in the set) followed by the **state classification** of each movement based on its origin/destination.
  Save Point group: By Airport & Intra/Inter

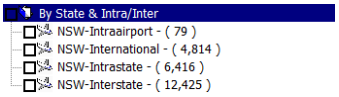



- **Inter/Intra** – This will produce up to four Save Points. Each Save Point created is based on the origin/destination **state classification** of each movement.
  Save Point group: By Intra/Interstate

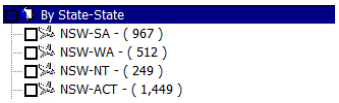



- **State by Intra/Inter** – This will produce up to four Save Points and has two parts. The first part will be based on

the **state** of the home airport for each movement (same for all movements in the set) followed by the **state classification** of each movement based on its origin/destination.
Similar to **Airport by Intra/Inter** save point type described above.
Save Point group: By State Intra/Inter

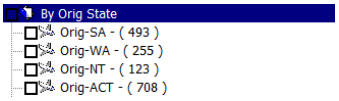



- **State by State Routes** – The first part will be based on the **state** of the home airport for each movement (same for all movements in the set) followed by the **state** of the associated origin/destination.
  Save Point group: By State-State




- **State of Destination** – Each Save Point starts with the text **Dest** to signify it is a State of Destination Save Point. Following this text the **state** of the movements destination airport will be added. The number of destination states defined in the movement set will determine the number of Save Points created.
  Save Point group: By Dest State

- **State of Origin** – Each Save Point starts with the text **Orig** to signify it is a State of Origin Save Point. Following this text the **state** of the movements origin airport will be added. The number of origin states defined in the movement set will determine the number of Save Points created.
  Save Point group: By Orig State




### 7.6.8 Time Period Group

- **Daily** – Save Points will be created based on the day of the year on which each loaded movement occurs. The name of the Save Point will be given a number between 001 – 365.
  Save Point group: By Daily
- **Day of Week** – Save Points will be created based on the day of the week that each loaded movement occurs on. Names will be given between Sunday through Saturday.
  Save Point group: By Daily
- **Hourly** – Save Points will be created based on the hour that each loaded movement occurs. Names will be assigned between 12 am – 11 pm.
  Save Point group: By Hourly
- **Month** – Save Points will be created for each month of the year that exists in the loaded movements. Names will be created from January through to December.
  Save Point group: By Month
- **Quarterly** – Save Points are based on which quarter the movement occurs in. Names are created for: Quarter 1 through Quarter 4.
  Save Point group: By Quarterly

- **Season** – Save Points are created for each season (based on standard season begin and end dates) in which each loaded movement occurs. Names will be created for First through to Fourth to avoid northern and southern hemisphere differences.
  Save Point group: By Seasons
- **Week** – Save Points are created based on the week during which each loaded movement occurs. Names will range from Wk 01 through Wk 52.
  Save Point group: By Weekly
- **Year** – Save Points will be created based on the year in which each loaded movement occurs. Names will be four digit year formats.
  Save Point group: By Year

# Part IV

# Footprint Analysis and Reporting

# Chapter 8

# Network Footprinting

## 8.1 Introduction

The key function of TNIP Carbon Counter is to facilitate the analysis and reporting of carbon footprinting for aviation across both single airports and airport networks. Previous chapters have described the process involved in loading both system and movement data and then how to use the Network Filter and Save Point tools to organise the data to facilitate analysis and reporting.

This chapter describes how the user can utilise these tools via the **Queries & Reports** interface to analyse and report on the carbon footprint of aviation operations in three broad areas - across entire networks, for corporate entities and for operations departing from a single airport or a user defined airport grouping.

## 8.2 Network Carbon Overview

This section details how the user can generate both high-level, and detailed, carbon footprint reports across networks. Select the Queries & Reports button on the main menu (*Figure 8*) to bring up the interface shown in *Figure 70*.

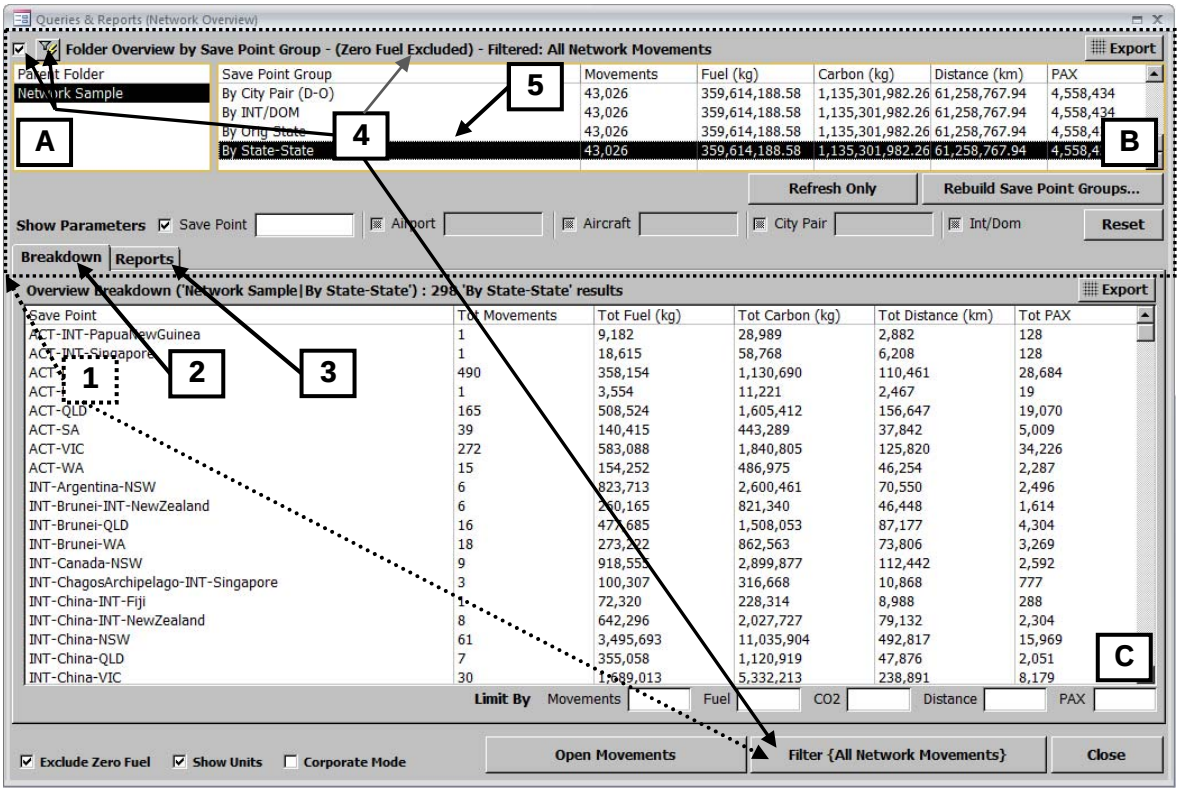



**Figure 70 Queries & Reports interface**

The **Queries & Reports** interface can be divided into three main areas:

- **[1] Data Selection**: Enables the user to choose which movements are to be included in an analysis, what grouping to organise the data in and whether to exclude particular

movements based on various parameters. This area is marked by the dotted area in *Figure 70*.

- **[2] Movement Analysis**: This tab (shown in *Figure 70*) is used to analyse the data at an individual Save Point level with the ability to drill down into the actual data. Individual movements and the breakdown data can be exported.
- **[3] Carbon Reporting**: This tab (shown in *Figure 70*) is used to create standard graphs and reports with a variety of user selectable metrics. The graph and overview metric data can be exported.

## 8.3 Data Selection

Selecting the data which is to be examined and reported on can be done in three different ways.

**Method 1**: The first way of selecting data is by the use of the **Network Filter** tool (refer to *Chapter 6* and *Subsections 8.3.1* & *8.3.2*). The **Network Filter** tool is used to determine which airport movements are included. From the **Queries & Reports** interface there are two ways of accessing the **Network Filter** tool. When a network filter is active the **Folder [A]** list and **Save Point Group [B]** list borders will change to an orange colour. If a network filter is not in use all airport movements in the selected folder will be used.

**Method 2**: The second is by the use of pre-compiled Save Points (*Subsection 8.3.3*). This determines the breakdown classifications used. Breakdown data and reports cannot be generated unless a Save Point group is selected. When selected, the Save Point group will be listed in the overview breakdown title. Save Points can be built while data loading via the **Data Input & Pre-processing** screen or via the **Save Point Builder** (see *Section 7.5*).

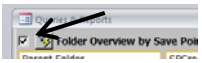
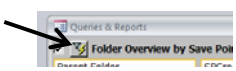
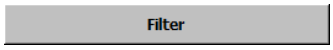
**Method 3**: The third method is via one or more of the various **Show Parameters** filters (*Subsection 8.3.4*). It limits the data from Method 1 and Method 2 based on the show parameter filters entered. By adding extra show parameters fields to the breakdown list the user can drill down further into the data.

All of these methods can be accessed in the dotted section marked **[1]** in *Figure 70*.

### 8.3.1 Network Filters

Network filters are an integral part of the **Queries and Reports** interface and as such there are two ways of both activating and modifying them. Additionally, the interface changes in a number of ways to convey to the user that network filters are currently being used.

There are three ways to turn network filtering on and are pointed to by **[4]** in *Figure 70*.

- Click the checkbox at the top of the screen. 
(The Network Filter tool is not displayed automatically)
- Click the small filter button beside the checkbox. 
- Click the 

button at the bottom of the screen. If a saved filter is currently active the name of the filter will be displayed on the button.

### 8.3.2 Network Filter Tool

When activated, use the network filter tool to select the desired movement sets to filter. Once activated, the current network filter can be displayed or edited at any time by clicking one of the buttons at **[4]**. For a detailed overview of the Network Filter tool refer to ***Chapter 6***.

When a filter is made active the interface changes in the following ways to alert the user:

- The checkbox at **[4]** is ticked.
- The border of the Folder list and Save Point Group list in the dotted Section **[1]** are changed to orange.
- The title of these lists **[1]** and the filter button caption at the bottom of the screen **[4]** changes to either display the name of the saved filter or, if unsaved, a number indicating the number of filtered airport movement sets.

To turn filtering off either remove the tick in the checkbox at **[4]** or click the Filter button at the bottom of the screen (also **[4]**) and click No when prompted (see ***Figure 71***). It is worth noting that the small filter button beside the checkbox will always display the Network Filter tool when clicked and cannot be used to turn the filter off.

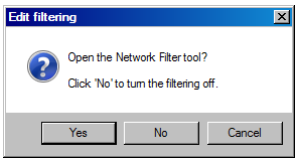



**Figure 71 Open or Turn Network Filtering Off dialog**

### 8.3.3 Grouping by Save Point

Using Save Points is another way of selecting data into logical groupings. There are two lists in the top half of the screen.

The **Folder** list **[A]** (top left list in ***Figure 70***) will show any folders in the currently loaded vault which have movements. If a filter is currently active only the movements in the filter will be displayed. When a folder is selected from this list the **Save Point Groupings** list (**[B]** in ***Figure 70***) will then be populated with a breakdown of these folder movements and organised in one line for each Save Point group that has been built.

Selecting an item in the **Save Point Grouping** list **[B]** this will cause the **Overview Breakdown** list (**[C]** lower half in ***Figure 70***) to be populated with the currently selected movements, arranged or grouped by the individual Save Points that make up the highlighted Save Point group.

The data displayed in the **Save Point Grouping** list **[B]** can be exported to another program by clicking the Export button at the top right hand side of the list. The displayed datasheet can then be copied and pasted into another application.

In summary, first select a folder and then select from a Save Point group. The currently available movements will then be displayed in the **Overview Breakdown** list **[C]** and is broken down by the individual Save Points from the group just selected.

#### Data Totalling Issues

In general the breakdown data for each entry in the **Save Point Groupings** list **[B]** should be the same, however, it is normal for differences to occur for understandable reasons.

Two examples for a valid difference include: The **By Aircraft Substitute** may be different because not all aircraft have been substituted, therefore, movements for the unsubstituted aircraft will not be counted in any total. The **By State-State** Save Point entry (pointed to by **[5]**) may be different because one or more airports have not been assigned a state and as a result movements to these airports will not be counted in the state totals

It is, however, also possible for differences to occur due to a corruption in a Save Point, a corruption in the summary data or a carbon count or Save Point build having been interrupted.

In the example in ***Figure 72*** the **YGLA Proximity x100** entry shows totals for Movements, Fuel, Carbon, Distance and PAX numbers which are all lower than the other four groups. This may be indicative of a Save Point build being interrupted or one of the airport details being unknown.

| SPGroup | Movements | Fuel | Carbon | Distance | PAX |
|---|---|---|---|---|---|
| By 500km Circles | 305,321 | 1,769,133,153.13 | 5,585,153,484.40 | 290,830,587.49 | 25,711,552 |
| By Aircraft | 305,321 | 1,769,133,153.13 | 5,585,153,484.40 | 290,830,587.49 | 25,711,552 |
| By PAX | 305,321 | 1,769,133,153.13 | 5,585,153,484.40 | 290,830,587.49 | 25,711,552 |
| By State-State | 305,321 | 1,769,133,153.13 | 5,585,153,484.40 | 290,830,587.49 | 25,711,552 |
| YGLA Proximity x100 | 145,478 | 1,711,299,363.54 | 5,402,572,189.87 | 253,817,067.44 | 22,669,348 |

**Figure 72 Save Points example**

If a Save Point has become corrupted it will need to be rebuilt or deleted and have a new Save Point group created in its place. It is possible to do this without leaving the **Queries & Reports** screen by opening up the Save Point Builder.

To open the **Save Point Builder** (***Figure 74***) click the Rebuild Save Point Groups button (refer to the dotted section marked **[1]** in ***Figure 70***). This will first open a dialog box (***Figure 73***) advising of the steps to take in order to update the overview groups.

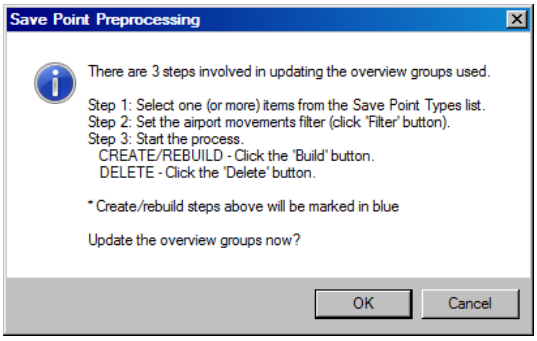

Save Point Preprocessing
There are 3 steps involved in updating the overview groups used.
Step 1: Select one (or more) items from the Save Point Types list.
Step 2: Set the airport movements filter (click 'Filter' button).
Step 3: Start the process.
CREATE/REBUILD - Click the 'Build' button.
DELETE - Click the 'Delete' button.
* Create/rebuild steps above will be marked in blue
Update the overview groups now?
OK
Cancel

**Figure 73 Save Point Instructions dialog**

Click the **OK** button on the dialog box to open the Save Point Builder.

When the builder opens, each of the steps listed in the dialog box will be marked in **blue** to highlight them.

- **Step 1**. Select the type of Save Point to build from the **Save Point Types** list. Any number of Save Points can be selected. Simply hold down the Control key so select more than one Save Point type at a time.
- **Step 2**. Select the airport movements to build Save Points for by clicking the **Filter** button at the bottom of the window. While the currently active filter is displayed in the text of this button, it may be best to click the button and confirm that the correct movements are included in the filter if the name is unclear or the contents have been changed. Creating a Save Point for a large number of airports can take a considerable amount of time, indeed, depending upon the number and type of Save Points created it could take hours when hundreds of airport movements are involved and especially if multiple Save Points are being generated.

- **Step 3**. Initiate the Save Point build by clicking the 3. Build button in *Figure 74*. If Save Points are to be deleted, click the Delete button instead. It is also possible to rebuild the Extras Save Points from this interface by clicking the Extras button.

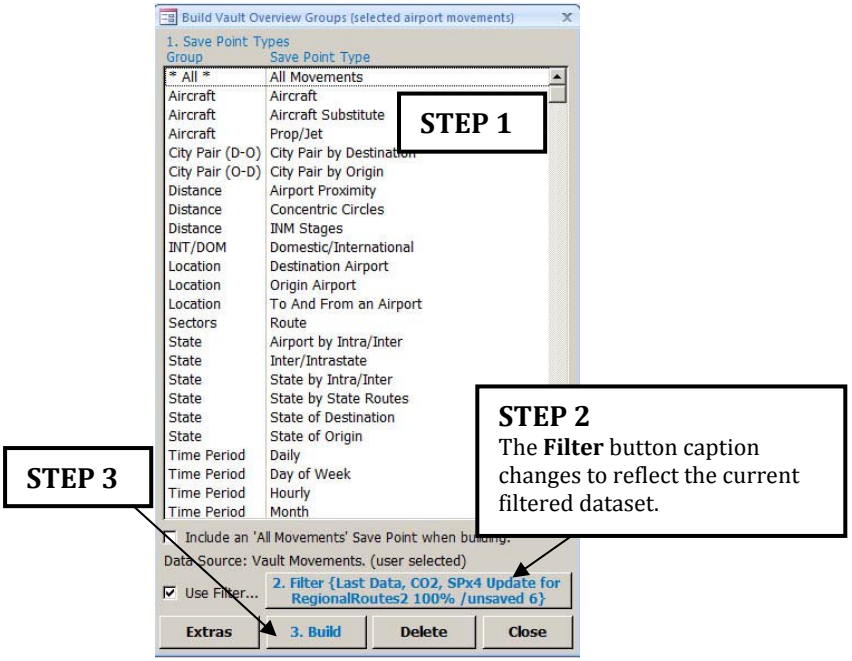



**Figure 74 Save Point Pre-processing Builder**

If any additional information is required this will be prompted when the build begins. For an in-depth discussion on Save Point management refer to *Chapter 7*.

If the **Save Point Group** list (**[B]** *Figure 70*) on the **Queries & Reports** screen becomes corrupted or a previous build was interrupted the breakdown data may be incorrect. There are a number of possible solutions to this problem.

- It may be possible to repair any Save Point problems by performing a quick refresh. To attempt a quick refresh of the existing Save Points click the Refresh button and the program will refresh all movements in the current network filter.
- As discussed above, it may be necessary to rebuild the Save Points in question by using the **Save Point Builder** interface via the **Rebuild Save Point Groups** button.
- Performing a carbon count for the affected airports may correct this problem.
- If the problem occurred because of an error during a data load then the data in error may need to be reloaded and all affected Save Points rebuilt. It is also worth noting that the data itself may be causing the problem in which case all data errors will need to be resolved first.

### 8.3.4 Filtering by Show Parameters

A third way of selecting data to be displayed is by the using **Show Parameters** marked at the bottom of the dotted box **[1]** in *Figure 70*. Depending upon how the **Show Parameters** options are set it is possible to specify how the data is categorised and the filters that will be placed on the data displayed.

Five different **Show Parameters** can be used for grouping and filtering. These parameters include:

- ☑ Save Point – The column Save Point will be displayed. Data will be categorised using the individual Save Points from the currently selected Save Point group. By default this option is turned on.
- ☑ Airport – The column A/P will be displayed. This is the name of the airport and not its ICAO code.
- ☑ Aircraft – The column A/C will be displayed. This is the ICAO code for the aircraft in the loaded movements.
- ☑ City Pair – The column City Pair will be displayed. Unlike the airport filter the city pair filter uses the ICAO airport code for the departure and arrival airports which are separated by a hyphen and no spaces in between.
- ☑ Int/Dom – The column DOMESTIC will be displayed where the text Yes represents a domestic airport and No represents an international airport. This option does not have a filter box.

The first four of these options can have one of three states while the 5th is either on or off. Each of these options relates to a specific field in the **Overview Breakdown** list (**[C]** *Figure 70*). The following is a discussion of the states of the first four options:

- ☑ **On – Checked**: The related column will be displayed in the Overview Breakdown list **[C]**. If any text has been entered into the text box next to this option this text will be used to filter the data in this column. By default the Save Point checkbox is initially checked. Adding a * will cause any text in this position to be matched.
- ☐ **Active – Unchecked**: Only available if text has been entered in this option's text box. When data has been entered and the check box is in this state the column is turned on but the list data is displayed differently. The text entered in the options text box (filter text) will filter the data in the relevant column in **Overview Breakdown** list **[C]**, however, the column will not show the actual data. Instead it will display the text: **Like '*int*'** where the filter text will be displayed in single quotes. This will effectively collapse the Save Point entries which match the filter text to a single line. Adding a * will cause any text in this position to be matched.
- ▩ **Ignored – Checkbox Greyed Out**: The column is not displayed and no filter will be active.

To quickly clear all parameters and reset them to their defaults, click the **Reset** button.

### 8.3.5 Limit By

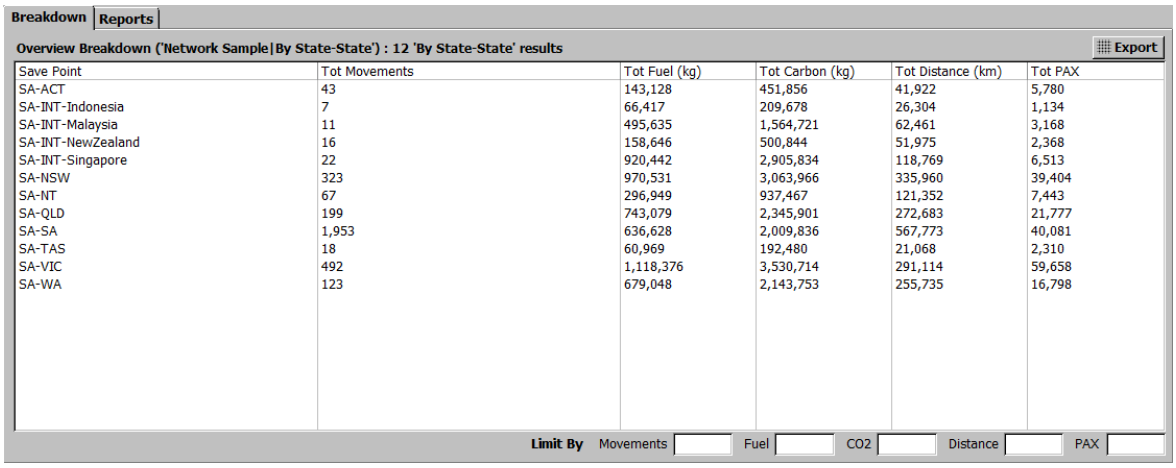
The Limit By field sitting underneath the Overview Breakdown list provides a way of limiting the data shown based on the aggregated total for the column the field relates to. When a number is entered into one of the text boxes only the lines which equal or are greater than that value will be displayed.

In effect these text boxes hide all lines in the filtered dataset where the value entered falls below the cut-off value entered in the box. This is designed to eliminate entries with small values that are hindering interpretation of the overall picture presented by the data.

## 8.4 Movement Analysis

Selecting the **Movement Breakdown** tab on the **Queries & Reports** screen (**[2]** *Figure 70*) brings up the movement analysis section shown in *Figure 75*. This tab is automatically selected when the **Queries & Reports** is opened.

Once a Save Point Group has been selected the data in the Overview Breakdown list **[C]** will change based on the Save Point group and the show parameters chosen. By default this breakdown list has a line for every Save Point in the selected group and is listed in the first column. Each line has five additional columns that show the totals for the line. The totalled columns include: Number of Movements, Fuel, Carbon, Trip Distance and number of PAX.




| Save Point | Tot Movements | Tot Fuel (kg) | Tot Carbon (kg) | Tot Distance (km) | Tot PAX |
|---|---|---|---|---|---|
| SA-ACT | 43 | 143,128 | 451,856 | 41,922 | 5,780 |
| SA-INT-Indonesia | 7 | 66,417 | 209,678 | 26,304 | 1,134 |
| SA-INT-Malaysia | 11 | 495,635 | 1,564,721 | 62,461 | 3,168 |
| SA-INT-NewZealand | 16 | 158,646 | 500,844 | 51,975 | 2,368 |
| SA-INT-Singapore | 22 | 920,442 | 2,905,834 | 118,769 | 6,513 |
| SA-NSW | 323 | 970,531 | 3,063,966 | 335,960 | 39,404 |
| SA-NT | 67 | 296,949 | 937,467 | 121,352 | 7,443 |
| SA-QLD | 199 | 743,079 | 2,345,901 | 272,683 | 21,777 |
| SA-SA | 1,953 | 636,628 | 2,009,836 | 567,773 | 40,081 |
| SA-TAS | 18 | 60,969 | 192,480 | 21,068 | 2,310 |
| SA-VIC | 492 | 1,118,376 | 3,530,714 | 291,114 | 59,658 |
| SA-WA | 123 | 679,048 | 2,143,753 | 255,735 | 16,798 |

**Figure 75 Queries & Reports movement breakdown**

The data displayed in the **Overview Breakdown** list can be exported to another program by clicking the Export button at the top right hand side of the list. Upon opening, the datasheet can then be copied and pasted into another application.

### 8.4.1 Limiting Data

If a large number of breakdown items are displayed it is possible to reduce this number by selecting a Save Point group that has fewer Save Point entries, by removing unnecessary Show Parameters or by limiting the data displayed using the **Limit By** or **Exclude Zero Fuel** options.

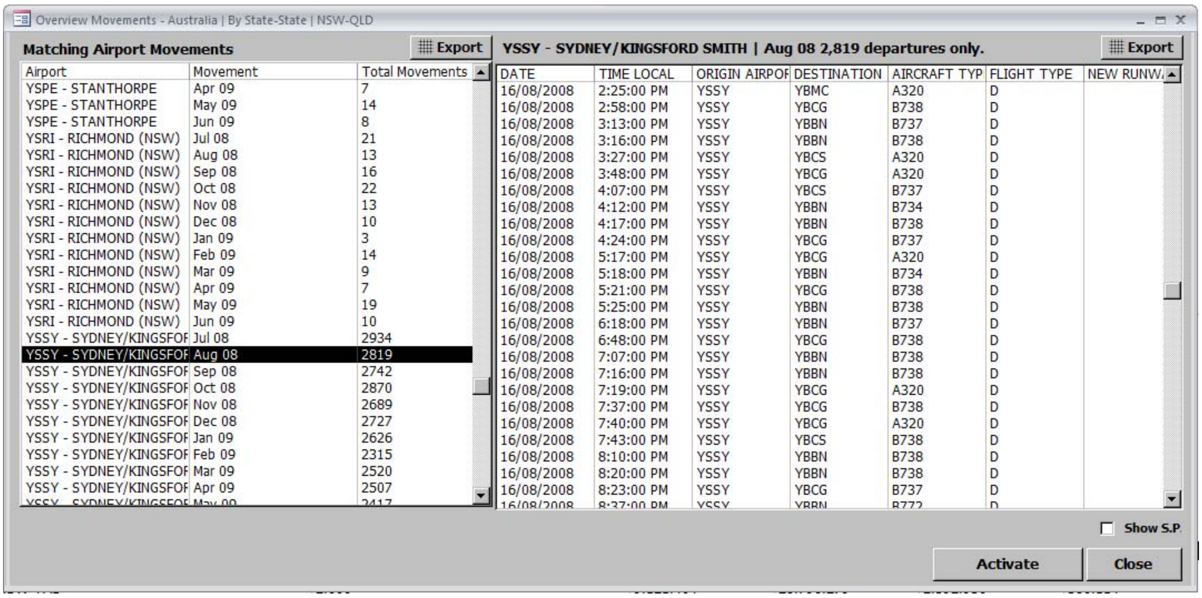
By using the **Limit By** options it is possible to limit the items displayed by excluding any lines where a group total in either the Tot Movements, Tot Fuel, Tot Carbon, Tot Distance or Tot PAX column falls under a particular value or threshold. To limit the data enter the threshold value in the relevant Limit By field. These fields are to the right and immediately underneath the Overview Breakdown list.

Often movements which have no fuel burn calculated for them are not required, however, entering a zero in the **Tot Fuel Limit By** field will not remove all zero fuel data, rather it will only remove list entries (or groups) which have zero fuel for all items in the group. If a group has 10 items and only one of those items has fuel burn, the Save Point group entry will be displayed and the Total Movements column will record 10 despite the fact that only one has fuel data! To overcome this problem the ☐ Exclude Zero Fuel checkbox has been provided which causes all entries with zero fuel data to be excluded before grouping occurs. Activating this feature will cause the entry with 10 items (9 with zero fuel) to change to having the **Tot Movements** column display '1' and not '10'. Similarly, the **Tot Distance** and **Tot PAX** columns will only show data for the single movement and not all ten.

### 8.4.2 Transparency

It is possible for a single line in the **Overview Breakdown** list to be made up of movements from literally hundreds of airports. While the list can be refined, often a better way of viewing the makeup of this data is to open the Overview Movements screen.

If an entry in the **Overview Breakdown** list is to be examined either select the item and click the **Open Movements** button or simply double click the item to bring up the interface at *Figure 76* and drill down into the underlying data.



Overview Movements - Australia | By State-State | NSW-QLD
Matching Airport Movements
Export
YSSY - SYDNEY/KINGSFORD SMITH | Aug 08 2,819 departures only.
Export
Airport | Movement | Total Movements
YSPE - STANTHORPE | Apr 09 | 7
YSPE - STANTHORPE | May 09 | 14
YSPE - STANTHORPE | Jun 09 | 8
YSRI - RICHMOND (NSW) | Jul 08 | 21
YSRI - RICHMOND (NSW) | Aug 08 | 13
YSRI - RICHMOND (NSW) | Sep 08 | 16
YSRI - RICHMOND (NSW) | Oct 08 | 22
YSRI - RICHMOND (NSW) | Nov 08 | 13
YSRI - RICHMOND (NSW) | Dec 08 | 10
YSRI - RICHMOND (NSW) | Jan 09 | 3
YSRI - RICHMOND (NSW) | Feb 09 | 14
YSRI - RICHMOND (NSW) | Mar 09 | 9
YSRI - RICHMOND (NSW) | Apr 09 | 7
YSRI - RICHMOND (NSW) | May 09 | 19
YSRI - RICHMOND (NSW) | Jun 09 | 10
YSSY - SYDNEY/KINGSFOF | Jul 08 | 2934
YSSY - SYDNEY/KINGSFOF | Aug 08 | 2819
YSSY - SYDNEY/KINGSFOF | Sep 08 | 2742
YSSY - SYDNEY/KINGSFOF | Oct 08 | 2870
YSSY - SYDNEY/KINGSFOF | Nov 08 | 2689
YSSY - SYDNEY/KINGSFOF | Dec 08 | 2727
YSSY - SYDNEY/KINGSFOF | Jan 09 | 2626
YSSY - SYDNEY/KINGSFOF | Feb 09 | 2315
YSSY - SYDNEY/KINGSFOF | Mar 09 | 2520
YSSY - SYDNEY/KINGSFOF | Apr 09 | 2507
DATE | TIME LOCAL | ORIGIN AIRPOF | DESTINATION | AIRCRAFT TYP | FLIGHT TYPE | NEW RUNW.
16/08/2008 | 2:25:00 PM | YSSY | YBMC | A320 | D
16/08/2008 | 2:58:00 PM | YSSY | YBCG | B738 | D
16/08/2008 | 3:13:00 PM | YSSY | YBBN | B737 | D
16/08/2008 | 3:16:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 3:27:00 PM | YSSY | YBCS | A320 | D
16/08/2008 | 3:48:00 PM | YSSY | YBCG | A320 | D
16/08/2008 | 4:07:00 PM | YSSY | YBCS | B737 | D
16/08/2008 | 4:12:00 PM | YSSY | YBBN | B734 | D
16/08/2008 | 4:17:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 4:24:00 PM | YSSY | YBCG | B737 | D
16/08/2008 | 5:17:00 PM | YSSY | YBCG | A320 | D
16/08/2008 | 5:18:00 PM | YSSY | YBBN | B734 | D
16/08/2008 | 5:21:00 PM | YSSY | YBCG | B738 | D
16/08/2008 | 5:25:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 6:18:00 PM | YSSY | YBBN | B737 | D
16/08/2008 | 6:48:00 PM | YSSY | YBCG | B738 | D
16/08/2008 | 7:07:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 7:16:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 7:19:00 PM | YSSY | YBCG | A320 | D
16/08/2008 | 7:37:00 PM | YSSY | YBCG | B738 | D
16/08/2008 | 7:40:00 PM | YSSY | YBCG | A320 | D
16/08/2008 | 7:43:00 PM | YSSY | YBCS | B738 | D
16/08/2008 | 8:10:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 8:20:00 PM | YSSY | YBBN | B738 | D
16/08/2008 | 8:23:00 PM | YSSY | YBCG | B737 | D
Show S.P.
Activate
Close


**Figure 76 Overview movement breakdown**

When the **Overview Movements** screen opens two lists are presented. The list on the left is populated with all the movements that make up the entry selected. This list is based on the airport and movement set combinations involved along with the number of movements for each combination.

When an item in the left hand list is selected the list on the right is populated with the actual movements making up this airport and movement set combination.

To view the movements in more detail, select the combination in the left hand list and click the **Activate** button and then click Yes on the subsequent dialog. It is important to note that doing this opens all the movements in the airport movement set and not just the ones listed in the Overview Movements screen.

## 8.5 Carbon Reporting

This area enables the user to generate rapid graphical output of disaggregated carbon footprints using a range of metrics. Alternatively the disaggregated datasets can be exported to other programs in order to generate more sophisticated graphics or to carry out further analysis.

Selecting the **Reports** tab on the **Queries & Reports** screen **[1]** brings up the reports section shown in *Figure 77*. The Reports section has four key areas: the metrics list **[A]**, report options **[B dotted section]**, graphics area **[C]** and the data area **[D]**.

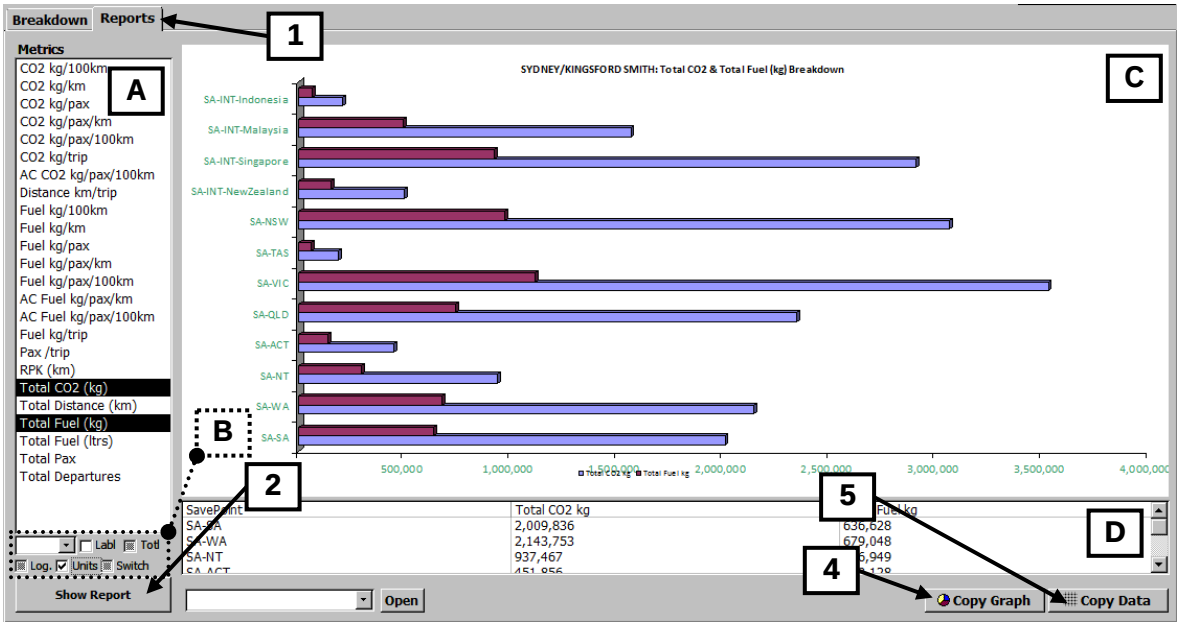
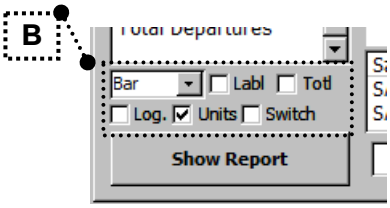



**Figure 77 Queries & Reports - Report tab**

**Metrics Area [A]** – this area contains a listing of different metrics for examining the data in the selected dataset or sets. All but one of the graph types can use one or more metrics. Pie charts can only use a single metric. As metrics are toggled on and off, the graph **[C]** and data area **[D]** will reflect these changes.

The metrics operate on the current network filter and the selected Save Point group. Comparisons between datasets can be made through the data selection area.




**Options Area [B]** – this area contains six options for customising the graph in **[C]**, one dropdown list and five checkboxes.

- Bar changes the style of the report to either: Bar, Column, Line, Pie or Donut.
- Labl Appends the y-axis of the graph to the end of each bar, column, line, pie or donut segment.
- Totl Appends the data value to the bar, column, line, pie or donut segment.
- Log. Converts the value scale of Bar, Column and Line graphs from an arithmetic progression to a logarithmic progression. This is useful when graphing two or more items that have largely disparate measurement scales or values.
- Units Adds or removes the unit of measurement from the metrics list, graph and data area.
- Switch Switches the x-axis and y-axis. If labels have been appended these will also be switched.

**Graphics Area [C]** – this area gives a graphical display of the results of the computation where the selected metric(s) have been applied to the selected Save Point groups. The form of the

graphic can be presented in a number of ways by selecting from the drop down list and checkboxes at **[B]**. To export the graph to another program, select the Copy Graph button **[4]** to place it on to the clipboard. Once on the clipboard it can then be pasted into another program.

**Data Area [D]** - this area contains the data which underlies the graphic at **[C]**. All metrics selected in **[A]** will be displayed in **[D]**.This data can be exported to another program by selecting the Copy Data button **[5]** and then pasting the copied data into another program.

## 8.6 Revenue Tonne Kilometres (RTK)

Revenue Tonne Kilometres (RTK) is one of the commonly used metrics to track levels of aviation activity. It is a core metric used by ICAO. For example, ICAO has adopted a fuel efficiency goal of achieving a 2% fuel efficiency improvement per annum using a fuel efficiency metric of litres per revenue tonne kilometres (L/RTK).

In Australia comprehensive freight data is not available for domestic operations and there is currently no robust method for validating RTK data relating to international operations. Validation of RTK data is important given the inherent uncertainties embedded in this metric (e.g. assumptions about passenger weight).

RTK data is generally derived by assuming a weight for passengers and using actual weights for freight. However, in many circumstances data is not available for freight. The RTK facility embedded in TNIP Carbon Counter has been designed to facilitate the computation of RTK data in the absence of freight data. The methodology is based on concepts associated with the ICAO Carbon Calculator.

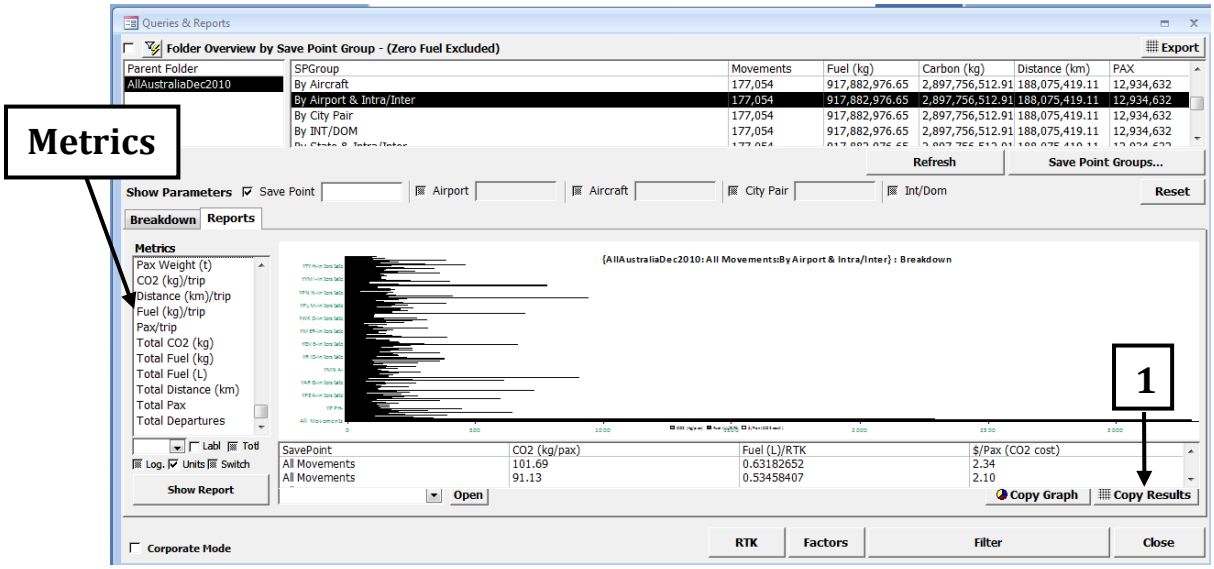



**Figure 78 Queries & Reports Interface – Report tab**

The factors for computing RTK can be entered by clicking the **RTK** button as shown at the bottom of ***Figure 78***. This brings up the **Setup Screen for RTK** window (see ***Figure 25***). Fuel efficiency metrics in terms of RTK (e.g. L/RTK, kg/RTK) can be found by selecting these metrics from the list shown under the 'Reports' tab . These metrics can be shown for any selected subset of the loaded dataset and be exported using the 'Copy Results' button **[1]** (***Figure 78***).

# Chapter 9

# Corporate Footprinting

## 9.1 Introduction

Many companies and organisations now have commitments to manage carbon footprints as part of their corporate social responsibility (CSR) agenda. This may involve, for example, an undertaking to operate as a 'carbon neutral' organisation. These commitments have little value without having established procedures in place for computing, validating and reporting carbon footprints. For many of these organisations a significant component of the carbon footprint derives from air travel by employees.

In response to the need to carbon footprint the aviation travel of employees, TNIP Carbon Counter includes a special mode which facilitates the importing of files listing the travel of individual company personnel and enables the computation and reporting of disaggregated carbon footprints.

This chapter first discusses the difference in the movements data file between corporate and standard TNIP modes and provides an example of how the corporate data file can be tailored to analyse emissions according to user-defined fields. ***Section 9.3*** then describes how to load and run a corporate movements file, while ***Section 9.4*** shows how the results can be viewed and accessed.

## 9.2 Corporate Movements Data File

When using the corporate mode a different format of input file is required. In the standard mode each line of data in an aircraft movements file relates to one flight. By way of contrast, while a corporate movements data file has the same basic format as the standard TNIP data file (see ***Section 5.2***), each line of data typically relates to a movement by one or move corporate passengers. The corporate file stores the number of corporate passengers travelling in an additional column called **PAX.** An example of a hypothetical corporate data file is shown in ***Figure 79***.

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| 1 | DATE | TIME LOCAL | ORIGIN AIRPORT | DESTINATION AIRPORT | AIRCRAFT TYPE | PAX | DIVISION | EMPLOYEE |
| 2 | 7/01/2009 | 17:17 | YSSY | YMML | B763 | 1 | Executive | Andrew Gordon |
| 3 | 9/01/2009 | 17:30 | YMML | YSSY | B738 | 1 | Executive | Andrew Gordon |
| 4 | 21/01/2009 | 08:46 | YSSY | VHHH | A333 | 1 | Executive | Andrew Gordon |
| 5 | 28/01/2009 | 08:16 | VHHH | YSSY | B744 | 1 | Executive | Andrew Gordon |
| 6 | 12/02/2009 | 07:20 | YSSY | YBBN | B738 | 1 | Executive | Andrew Gordon |
| 7 | 15/02/2009 | 17:40 | YBBN | YSSY | B763 | 1 | Executive | Andrew Gordon |
| 8 | 3/03/2009 | 08:25 | YSSY | WSSS | B744 | 1 | Executive | Andrew Gordon |
| 9 | 8/03/2009 | 06:30 | WSSS | YSSY | B772 | 1 | Executive | Andrew Gordon |
| 10 | 10/03/2009 | 06:22 | YSSY | YBBN | B734 | 1 | Corporate | Anita Baker |
| 11 | 14/03/2009 | 17:01 | YBBN | YSSY | A320 | 1 | Corporate | Anita Baker |
| 12 | 13/03/2009 | 17:29 | YSSY | YPAD | B738 | 1 | R&D | Bryan Perry |
| 13 | 16/03/2009 | 17:21 | YPAD | YSSY | B738 | 1 | R&D | Bryan Perry |
| 14 | 4/02/2009 | 06:11 | YSSY | YMML | B738 | 1 | Corporate | Charlotte Reid |
| 15 | 6/02/2009 | 20:46 | YMML | YSSY | B763 | 1 | Corporate | Charlotte Reid |
| 16 | 9/01/2009 | 06:11 | YSSY | YMML | B738 | 1 | Human Resources | Chris Turner |
| 17 | 10/01/2009 | 17:48 | YMML | YSSY | B737 | 1 | Human Resources | Chris Turner |
| 18 | 5/01/2009 | 06:30 | YSSY | YMML | B738 | 1 | R&D | David Connor |
| 19 | 7/01/2009 | 15:12 | YMML | YSSY | B763 | 1 | R&D | David Connor |

**Figure 79 Sample Corporate Movements Data File**

This sample here has only one passenger for each movement and shows, for each employee, the outbound and, if it exists, the return trips on separate lines. As TNIP Carbon Counter computes carbon emissions from departures only, in order to compute the total carbon emissions for an

employee's round trip, each leg of the journey (including return trip) must be entered on a separate line in the data file.

The first five columns in the data file above are the standard TNIP fields of **Date, Time, Origin, Destination** and **Aircraft Type**. This is followed by the compulsory **PAX** field representing the number of employees on each flight (this example has one for each movement). TNIP Carbon Counter uses the information in this column to compute the total carbon that can be ascribed to the company/organisation for each flight.

TNIP Carbon Counter provides for extra columns to be included with the imported data (see the **Extras** discussion in ***Subsection 5.3.7***) to facilitate data filtering and disaggregated analysis and reporting by using save points based on the data from these columns. The additional extra columns in the sample above are called **DIVISION** (Column G) and **EMPLOYEE** (Column H).

There are no limits to the number or type of **EXTRAS** fields that can be set up. A company may wish for example to include in its corporate file an additional field such as **SEAT TYPE** which shows the class of ticket purchased (e.g. business, premium economy, economy, etc.) in order to compute the carbon contributions from each of these classes.

## 9.3 Counting the Corporate Footprint

As for a standard TNIP run, the corporate data file is loaded and processed through the **Data Input & Pre-processing** interface. This was first shown in ***Section 5.3***, and is shown again in ***Figure 80*** in order to describe the specific steps involved in loading a corporate data file.

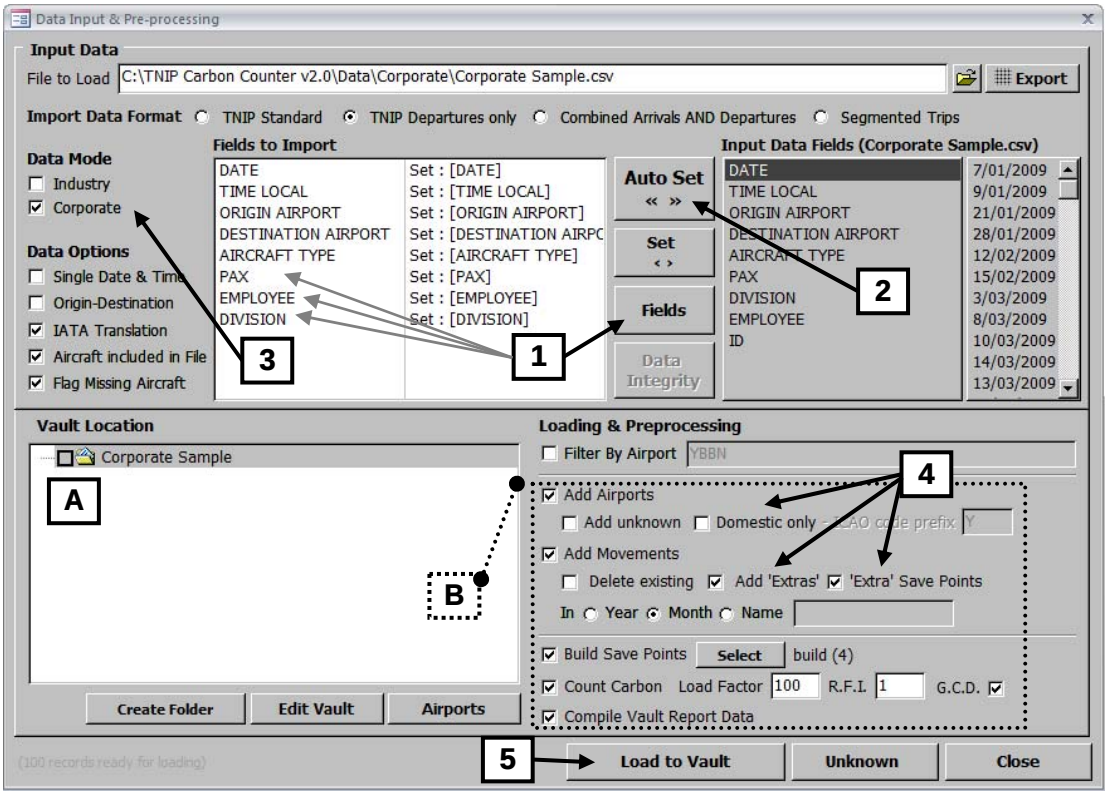



**Figure 80 Loading and Processing a Corporate Movements Data File**

As usual, the data file to be loaded is selected by clicking on the button located at the top right of the interface.

Extra fields are a feature of corporate reporting. In particular the **PAX** column (or field) must be selected to identify to the program that corporate data is being loaded. To include the extra data, including **PAX**, click on the **Extras** button **[1]** to bring up the **Extra Fields to Import** interface shown in ***Figure 81***.

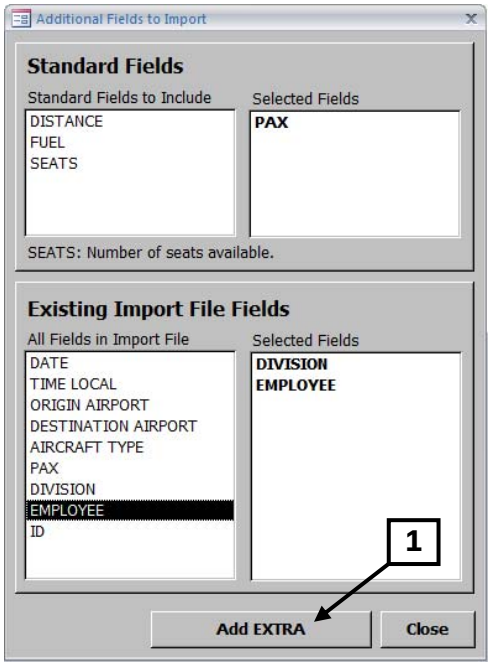



**Figure 81 Window for importing Extra Fields**

As discussed, for a corporate run the **PAX** must be included. To include this field double click the **PAX** entry in the **Standard Fields to Include** list shown at the top left. Double clicking this field will move it (**PAX**) to the **Selected Fields** list on the top right.

Alternatively, the **PAX** field can be added automatically and a quick check made on the state of the ☐ Domestic only, ☐ Add 'Extras' and ☐ 'Extra' Save Points options **[4]** by clicking the ☐ Set Corporate Mode checkbox **[3]** on the **Data Input & Pre-processing** screen as shown in ***Figure 80***.

To enhance reporting, additional user-defined fields such as the **DIVISION** and **EMPLOYEE** fields displayed in the example in ***Figure 81*** in the bottom left list box titled **All Fields in Import File**, can be added by double clicking each of these fields. Alternatively, fields can be added (or removed), including **PAX,** by first selecting the field from relevant list and using the add/replace button at the bottom of the screen (marked as **[1]**). The name of this button changes according to the list selected.

Upon selecting the required extra fields and closing the **Extra Fields to Import** screen the program returns the user to the **Data Input & Preprocessing** interface (***Figure 80***) where the added extra fields will be displayed in the **Required Fields** list (marked by three grey arrows). The user then needs to click the **Auto Set** button **[2]** on this screen to assign the extra fields to their relevant columns from the data file.

The next step involves selecting a folder from the **Vault Location** list **[A]** in ***Figure 80***. If no folders exist which can be used, press the **Create Folder** button underneath the **Vault Location** list to create a new folder.

Following this, set the required processing options in the Data Load & Preprocessing Options section **[B]** in ***Figure 80*** (refer to ***Section 5.5***).

When loading corporate data it is important to clear the ☐ Domestic only checkbox **[4]** in order include the compilation of movements and statistics from international airports. If any extra columns were selected the ☐ Add 'Extras' and ☐ 'Extra' Save Points options should be checked.

Finally, to process the data file, click the **Load to Vault** button marked by **[5]** in ***Figure 80***.

## 9.4 Analysing and Reporting the Corporate Footprint

Corporate footprint analysis and reporting is accessed via the **Queries and Reports** interface discussed in ***Section 8.2*** and shown again below in ***Figure 82***.

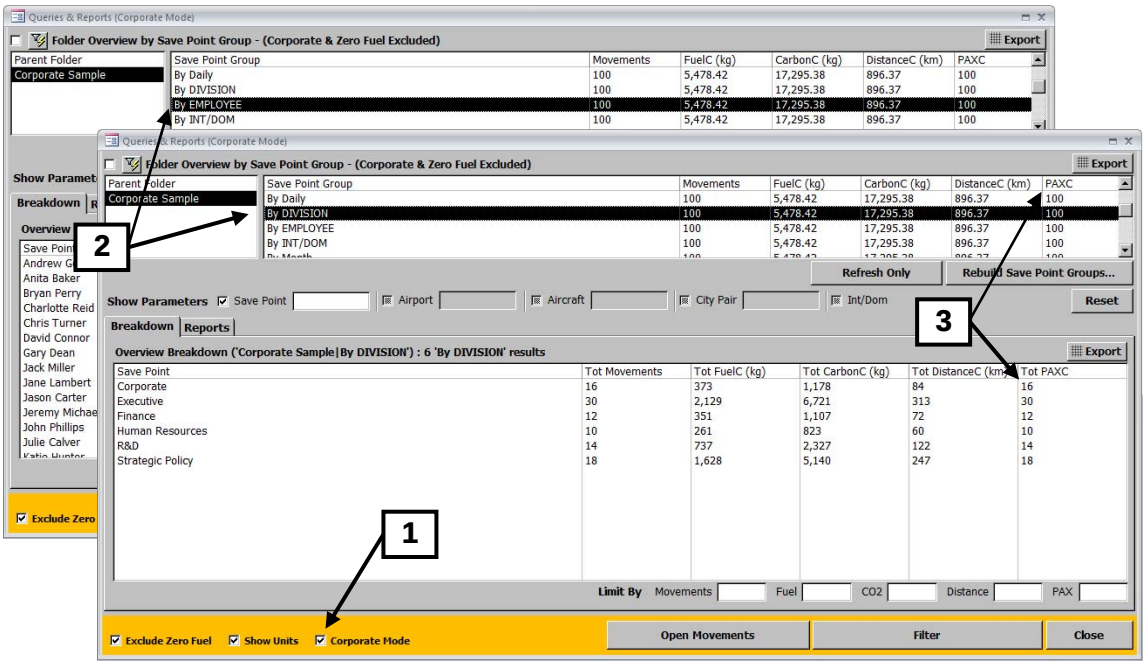



**Figure 82 Queries & Reports window for a sample corporate run**

To engage the corporate footprinting mode in the **Queries & Reports** interface, check the ☐ **Corporate Footprinting Mode** checkbox at **[1]**. Activating corporate footprinting will cause this screen to switch to corporate mode – when this is done the band at the bottom of the screen will be changed to a solid orange colour.

Setting this option will also make changes to the **Save Point Group** and **Overview Breakdown** lists by appending **'C'** to the name of the four standard data columns **[3]** to signify that the columns now represent a corporate **PAX** adjusted amount. To turn corporate mode off uncheck the ☑ **Corporate Footprinting Mode** option.

The analysis and reporting functions of the corporate mode are similar to those of the standard mode.

The data in the corporate dataset can be filtered by use of Save Points in the same way as is used in the standard mode. This enables the user to perform disaggregated analysis and reporting of corporate carbon footprints in a totally analogous way to the standard mode.

To illustrate the way in which the mode works assume that the corporate dataset shown in ***Figure 79*** has been loaded and processed in the program with Save Points set up for the EXTRAS

fields **DIVISION** and **EMPLOYEE** (see *Section 5.3.7* for creating EXTRAS Save Points). In the Queries & Reports interface, the **DIVISION** and **EMPLOYEE** Save Points will appear in the SPGroup list as shown in *Figure 82*.

In the example in *Figure 82*, clicking on the **By DIVISION** entry in the **Save Point Group** list **[2]** will show the total carbon emissions broken down into categories specified under the **DIVISION** field in the data file, i.e. Executive, Corporate, R&D, Human Resources, etc. Similarly clicking on the **By EMPLOYEE** in the **Save Point Group** list (also **[2]**) will show the contribution from each employee towards the company's total carbon emissions.

A worked example of the type of data that can be extracted, and reports generated, from the sample corporate data file above is discussed in *Section 12.6*.

# Chapter 10

# Industry Mode

## 10.1 Background

In arriving at a value for the CO2 generated from a flight, or a number of flights, TNIP Carbon Counter works through an aircraft operations file and computes the distance travelled for each flight using a great circle algorithm. The program translates this distance to the amount of fuel used for each flight through applying the fuel use data for individual aircraft types specified in the Corinair dataset. Per passenger CO2 information is determined by ascribing a number of seats to individual aircraft types and applying a value for the load factor on the flight(s) involved.

While validation testing to date indicates that this computational approach is giving robust results (ref.), clearly if the user has actual data for any of the above factors then it is preferable that this 'real data' be used. Version 2.0 of TNIP Carbon Counter contains a mode (the 'industry mode') which enables actual data, rather than computed data, to be used to arrive at the CO2 footprint of flights.

It is likely that most industry operators will have datasets which contain the necessary 'actual' information to arrive at the CO2 footprint.

## 10.2 Overview of Functions

In its standard operating mode the carbon footprints are computed using aircraft activity files which are loaded into *TNIP Carbon Counter*. These files contain information on the date and time of each departure, the origin and destination airports and on the aircraft types for each flight. When operated in the industry mode, the input files have fields which contain information on the actual distance flown; the actual fuel used; and the actual number of seats and passengers on each flight. When data is loaded in this mode, the program will detect if any actual data has been provided in the loaded data file. If there is actual data the program will use this, rather than computed data, in order to derive the carbon footprint.

When in this mode, the program will compute the $CO_2$ using the standard embedded algorithms if there are some missing individual entries in an 'actual' dataset. While the program uses actual data to derive and report the carbon footprint when in the industry mode, it also computes and displays the carbon footprint for each flight using the standard embedded algorithms. This comparison provides a convenient route for cross comparing the 'actual' with the 'computed' values for all the indicators in the program. This is useful for validation and also for gaining an understanding of the variability, and hence likely sources of error, associated with individual elements of the standard $CO_2$ computations.

While some of the key computational features of *TNIP Carbon Counter* are not required when actual data is available, the application is still a valuable tool for industry users as it provides an organised, and easily accessible, archive for large datasets. Data contained in the program vaults can be rapidly dissected into subsets to compute partial footprints and can be exported to other software programs to enable further analysis and reporting.

## 10.3 Loading a Data File in Industry Mode

The data loading interface (*Figure 83)* is accessed via the **Data Input and Pre-processing** button on the main menu. To commence loading a data file in the industry mode select the 'Industry' box at **[1]**. This brings up four new data import fields: 'distance'; 'fuel'; 'pax' and 'seats' **[2]**. These fields need to be present as columns, with the correct header names (i.e. 'distance', 'fuel', 'pax' and 'seats'), in the file being imported. The distance is input as kilometres and the fuel as kilograms.

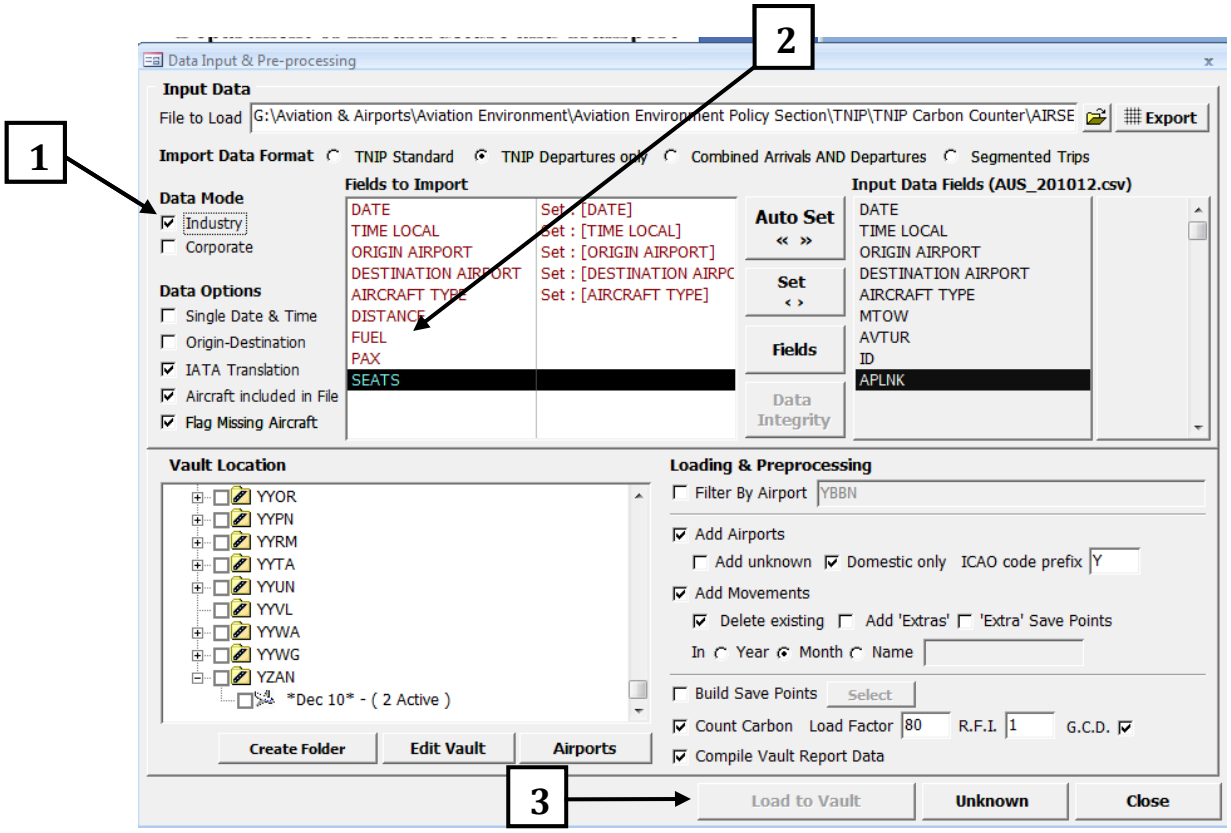



**Figure 83 Industry Mode – Data Input & Pre-processing Interface**

When the file is loaded correctly and the program has verified the data fields, the **Load to Vault** button **[3]** becomes activated and the data can be loaded into a vault in the normal manner.

## 10.4 Queries and Reports in Industry Mode

The Industry **Queries & Reports** interface (*Figure 84)* is accessed via the **Queries & Reports** button on the main menu. The blue band at the bottom of the interface indicates to the user that the program is being used in the industry mode.

When subsets are shown under the 'Breakdown' tab, two columns are shown for the fuel, carbon and distance parameters. The data in the columns with the normal headings **[1]** is the value of the actual data in the input file for a given selection; the data in the columns with the '~' prefix **[2]** is data the program has computed using the standard embedded algorithms. This comparative analysis between 'actual' and 'computed' data can be exported to MS Excel using the 'Export' button at **[3]**.

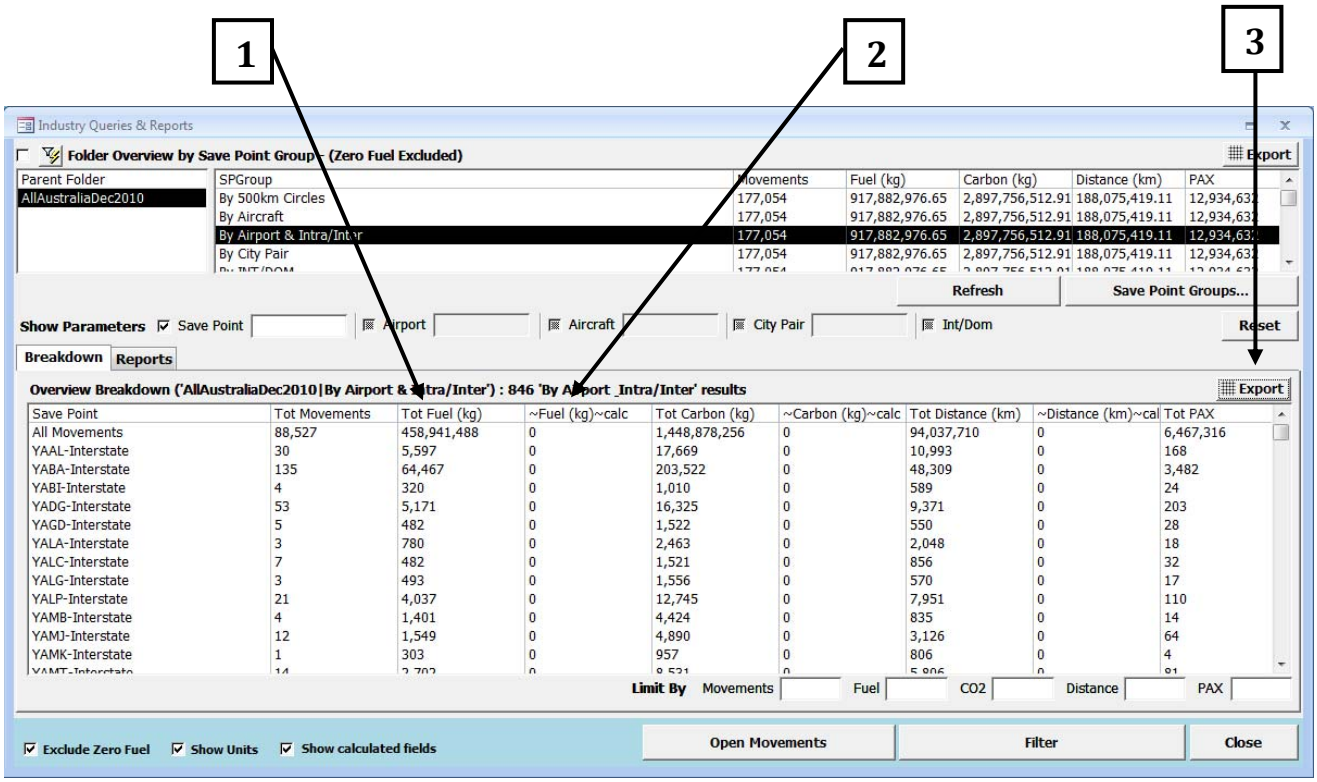



**Figure 84 Industry Mode – Data Input & Pre-processing Interface**

# Chapter 11

# Airport Based Analysis

This module of TNIP Carbon Counter provides the user with the ability to carry out detailed analysis and reporting of the aircraft departures from any airport that is contained within a loaded Vault. While this part of the program is focussed on a selected airport, it is important to recognise that it is solely computing the notional carbon arising from departures from the selected airport to the first port of call. As such it is computing the carbon based on notional fuel uplifted by the aircraft. It does not include any carbon which is related to activities associated with servicing the flight (e.g. ground service equipment) which would typically be provided by the airport operating company.

## 11.1 Introduction

The airport based analysis functions of the program are accessed by selecting the **Active Movements** button on TNIP Carbon Counter's main menu which is shown in ***Figure 85***. Once the program has been set up and data has been loaded, the movements at an individual airport can be activated. The previously activated movement file (active dataset) is automatically loaded and displayed in the title bar of the main menu (see ***Figure 8***).

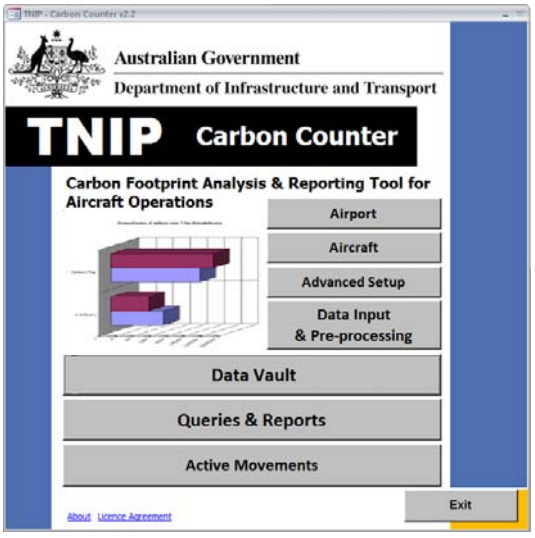



**Figure 85 Main Menu**

## 11.2 The Movements Tab

Selecting the large

button brings up the **Active Movements** screen as seen in ***Figure 86***. Initially the **Active Movements** screen is opened on the Movements tab **[1]**, however, when re-opened it starts up on the tab that was active when last shutdown. If the Movements tab is not displayed click the Movements tab to make it active.

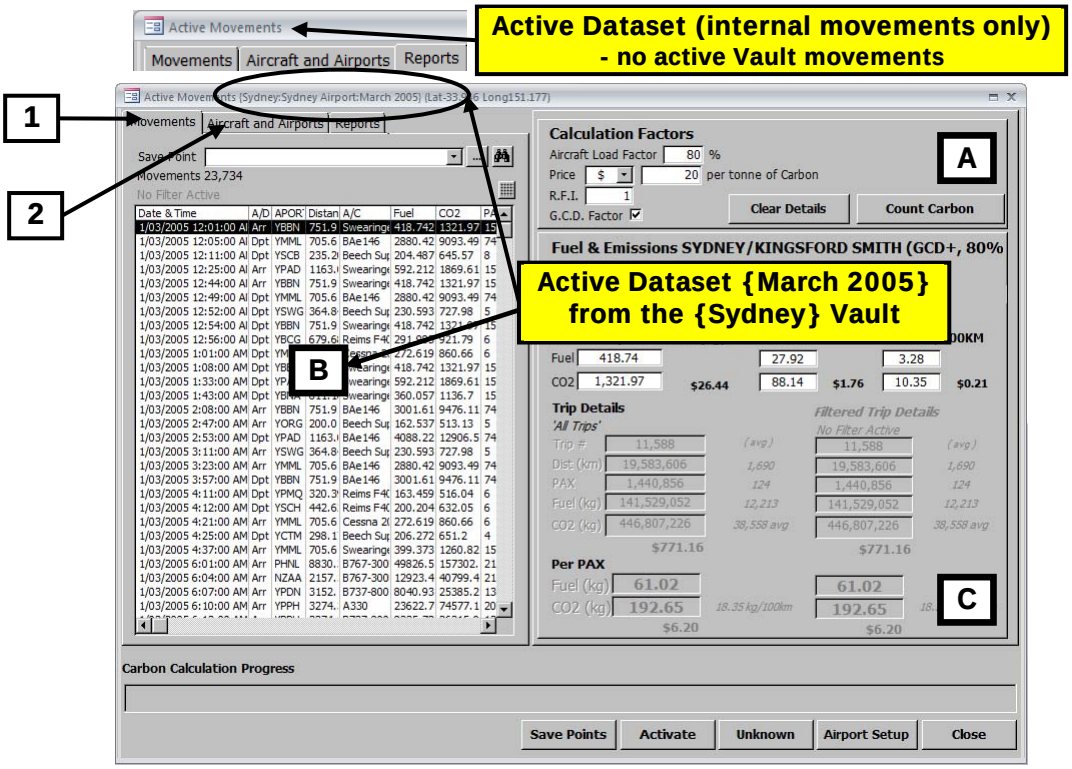



**Figure 86 Carbon Counter interface**

When the Movements tab of the **Active Movements** screen is selected, there are three main areas of interest: **Calculation Factors**, **Data Window** & **Fuel & Emission Statistics**.

- The **Calculation Factor** area **[A]** (and shown in ***Figure 87***) lets the user enter a value for the load factor, the price of carbon the RFI and to select the ICAO factor for adjusting Great Circle Distance GCD (see ***Subsection 13.2***). The user is only able to enter one generic value for the load factor.
  The RFI – the Radiative Forcing Index – is a factor to take account of the non-$CO_2$ climate change impacts of aviation. The application of an RFI is a matter of some debate and the user is recommended to read the relevant literature on this topic if they are not familiar with the concept.

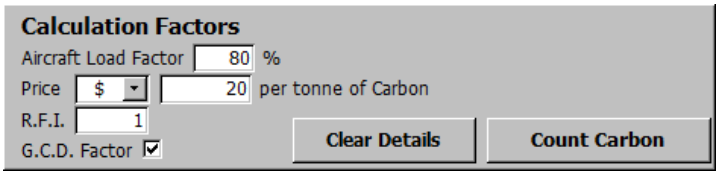



**Figure 87 Carbon Counter Interface - Calculation Factors Section**

- The **Data Window** **[B]** provides a window on the listing of the currently active aircraft movements dataset. The movements listed here can be sourced from either; movement data loaded directly into the internal TNIP Carbon Counter tables; or from an *activated* movement file from inside the current vault – the name of current active Vault movements are displayed in the title bar of various windows. The information shown in this window shows key parameters from the currently active aircraft movements dataset plus derived information such as distance, fuel use, $CO_2$ generated and number of seats (see ***Figure 88***).

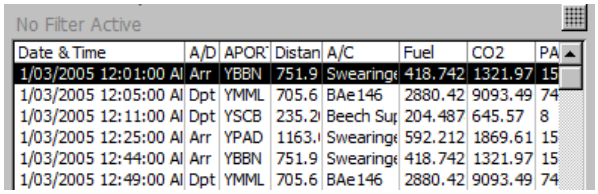



**Figure 88 Carbon Counter interface – the data window**

- The **Fuel & Emission Statistics** of queries/actions are shown in the area at the bottom right **[C]** of ***Figure 86***. Below is an exploded view of this Section and shows the four sub-areas within this Section: Current Trip Seating and Distance Travelled **[C-A]**, Current Trip Fuel & $CO_2$ **[C-B]**, aggregated Trip Details **[C-C]**, and aggregated Filtered Trip Details **[C-D1]** & **[C-D2]**.

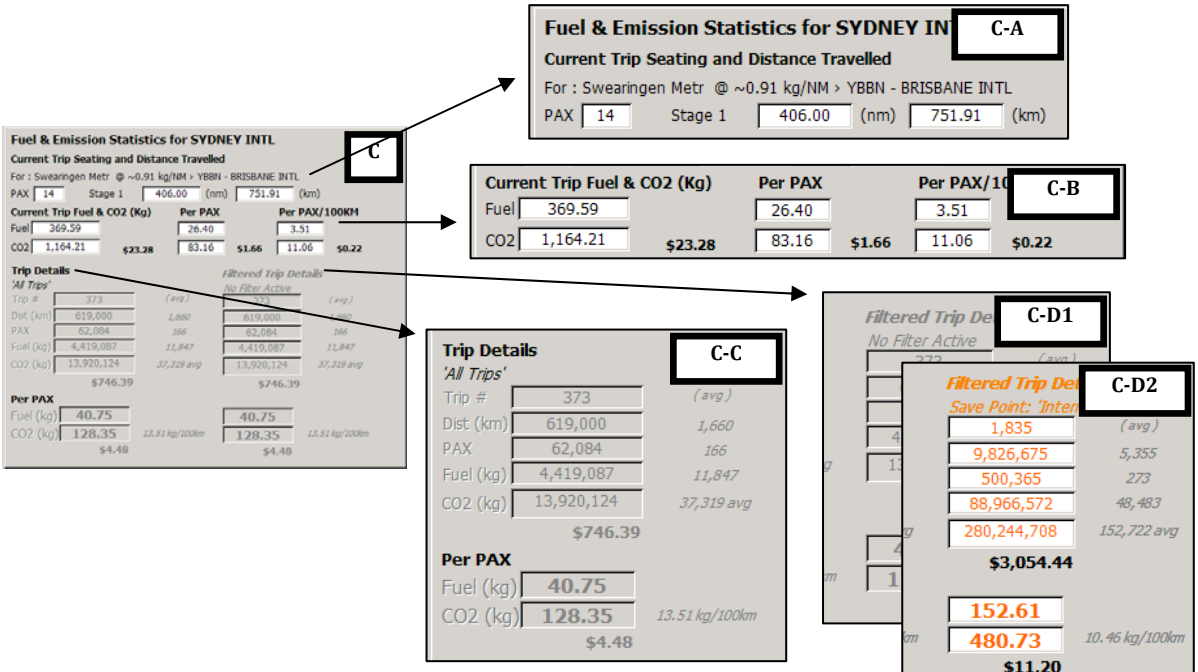



**Figure 89 Fuel & Emission Statistics for … Section exploded view**

During carbon counting only departures are included, therefore Trip Details **[C-C]** and Filtered Trip Details **[C-D1]** & **[C-D2]** will only include departures. When no Save Point is selected the filtered trip details will be greyed out and given the title *`No Filter Active'* **[C-D1]** and will be either blank or show details for all departures. When a Save Point has been selected the Filtered Trip Details section will be displayed in orange **[C-D2]** and only the relevant departure movements for the selected Save Point will be included in the aggregated totals.

The fields in **[C-C]** and **[C-D1]**/**[C-D2]** are each split into two further Sections;

- Top Section: '**All Trips'** **[C-C]**/**Filtered Trips [C-D2]**
- Bottom Section: **Per PAX** **[C-C]**/**Filtered Per PAX [C-D2]** (no header is present)

Top Section: The All Trips/Filtered Trips sections show aggregated totals for 'all departures' and 'all departures in the selected filter' respectively. Next to a number of fields are values in italics which show an average value for the field. The fields in this Subsection, in order from top to bottom are;

- **Trip #** - The number of all departures.
- **Dist (km)** - Total distance of all departures and *average distance of departures*

- **PAX** – Based on the number of seats for the aircraft type contained in the Aircraft (Substitution) file and the load factor entered. Total number of passengers (based on the load factor) for all departures and *averaged passengers per flight across departures*.
- **Fuel (kg)** - Total fuel in kilograms for all departures and *average kilograms of fuels used across all departures*.
- **CO2 (kg)** - Total derived $CO_2$ in kilograms for all departures and *average kilograms of $CO_2$ across all departures.*
- Monetary value for $CO_2$ generated.

Bottom Section: This section shows details of averaged values on a per passenger basis.

- **Fuel (kg)** – The averaged fuel in kilograms used per passenger.
- **CO2 (kg)** – The averaged derived $CO_2$ in kilograms per passenger and derived *$CO_2$ per passenger per 100 kilometers.*
- Monetary value for $CO_2$ on a per passenger basis.

After setting the calculation factors (***Figure 87***) the user can step through the listing of movements in the data window. Fuel/carbon/$CO_2$ cost information for the selected individual flight is shown in the boxes in the **Fuel & Emissions Statistics** Section.

## 11.3 The Aircraft and Airports Tab

Selecting the **Aircraft and Airports** tab **[2]** of ***Figure 86*** brings up the interface at ***Figure 90***. This is the same as the first screen except that the window which showed the detailed movements listing now shows an aggregated version of the aircraft movements file. This allows the user to step through the dataset at either the aircraft type **[A]** or airport **[B]** level (as opposed to the movement by movement level of the first screen). The user can select an aircraft type and then step through all the routes that the selected aircraft is used on. Alternatively a route can be selected and the user can step through the aircraft types that are used on that route. Each selection generates fuel/carbon/offset information in the window at **[C]** in a similar manner to the movements tab.

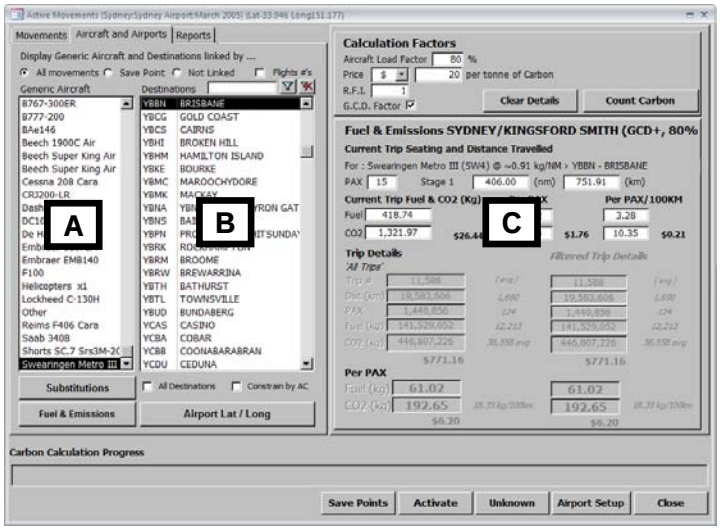



**Figure 90 Carbon Counter (Aircraft and Airports tab) interface**

## 11.4 Counting Carbon

To this point information has been shown for individual flights, aircraft types or routes. All the data can be aggregated by selecting the Count Carbon button [1] in *Figure 91*. The screenshot below demonstrates a carbon count in progress.

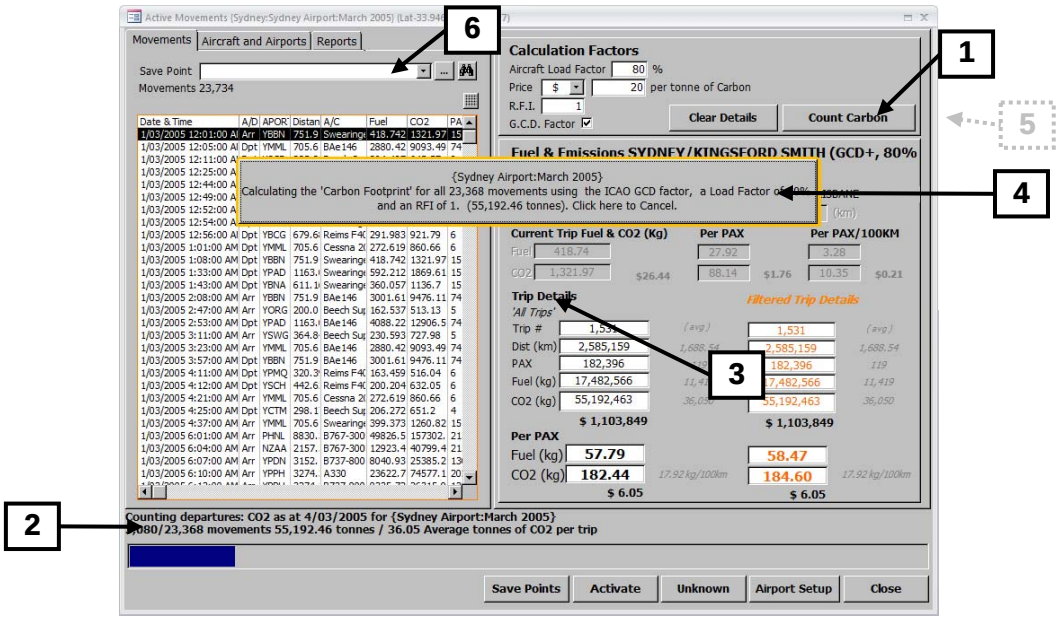



**Figure 91 Carbon count in progress**

When selected the program progressively sums up the information for each operation in the aircraft movements file. During the carbon count a progress bar along with information on the count is progressively updated and shown in the area above the progress bar at [2] and in the boxes in the **Fuel & Emissions statistics** section at [3]. During the counting process the count can be interrupted at any point by clicking on the 'click to pause' box [4] that appears in the middle of the screen. Counting can be re-started by selecting the restart button [5] that appears next to the Count Carbon button when counting is interrupted (*Figure 92*).

**Figure 92 Carbon Counter - Count and Resume button**

When the count has been completed the information in the boxes at [3] shows carbon count information for the whole of the active data file.

While the process described so far is related to the currently active movements it may be necessary to count the carbon for all movement sets in the Vault. For instance, if fuel burn data for one or more aircraft has been changed the carbon already calculated for all movements in the Vault, including the currently active one, does not change or update until a new carbon count is performed on each and every movement set.

While it is possible for the user to successively activate and then count the carbon for each movement set in the Vault this has the potential to be a time consuming process and requires the user to actively wait for the count to finish before activating the next movement set. To access the automated 'whole of Vault' procedures for counting any or all movement sets the user clicks on the Count Carbon button in the usual manner. When prompted with the Count Carbon dialog, the

user selects the 'No' button and then 'Yes' on the subsequent Count Carbon in Vault confirmation dialog in ***Figure 93***.

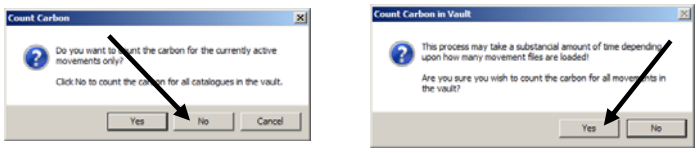



**Figure 93 initiating a 'whole of Vault' carbon count**

The user will then be prompted with the **Network Filter** interface (refer to ***Chapter 6***) where they can select the desired movement sets to be counted. When all desired movements are present in the right hand list, click the **Close** button to begin the process of successive movement activation and carbon counting. As each movement set is processed the standard **Click here to Cancel** progress dialog is modified to include the current movement set being processed. It is possible to cancel the whole process by clicking the modified **Click here to Cancel** button in much the same way as a normal carbon count.

### Examining Filtered Data

Referring back to ***Figure 91***, the information shown in the boxes at **[3]** relates to the whole of the active dataset. Subsets of the main database can be readily selected by accessing the Save Points using the drop down list at **[6]**. All three Save Point groups in the listing shown in ***Figure 94*** (**By 500km Circles**, **By PAX & By To And From**) were built up using the Save Point builder which is explained in ***Chapter 7***.

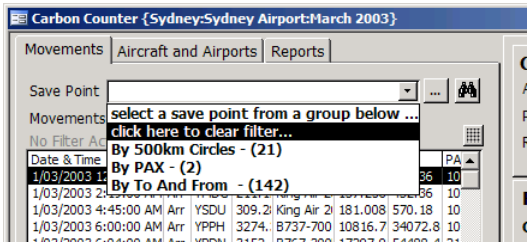

Carbon Counter {Sydney:Sydney Airport:March 2003}
Movements
Aircraft and Airports
Reports
Save Point
Movements
select a save point from a group below ...
click here to clear filter...
By 500km Circles - (21)
By PAX - (2)
By To And From - (142)
Date & Time
1/03/2003 4:45:00 AM Arr YSDU 309.2 King Air 2 181.008 570.18 10
1/03/2003 6:00:00 AM Arr YPPH 3274. B737-700 10816.7 34072.8 10

**Figure 94 Carbon Counter Interface –Save Points List at top level**

Selecting one of the parameters in the list opens up an expanded breakdown of the data. When a group item is selected, such as the **By PAX** group, the items in the list will change the Save Points for that group, subsequently selecting one of these Save Points causes it to be made active (see ***Figure 94***).

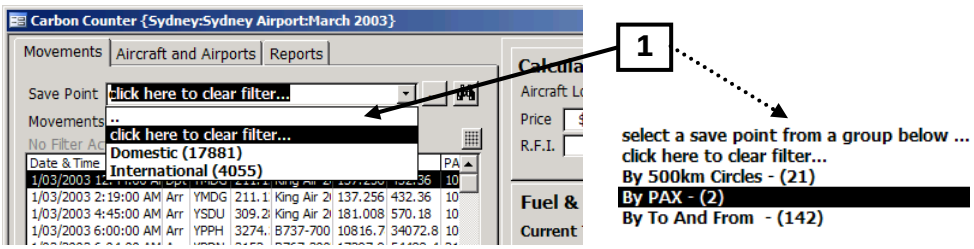

Carbon Counter {Sydney:Sydney Airport:March 2003}
Movements
Aircraft and Airports
Reports
Save Point
click here to clear filter...
Movements
..
click here to clear filter...
Domestic (17881)
International (4055)
Date & Time
1/03/2003 2:19:00 AM Arr YMDG 211.1 King Air 2 137.256 432.36 10
1/03/2003 4:45:00 AM Arr YSDU 309.2 King Air 2 181.008 570.18 10
1/03/2003 6:00:00 AM Arr YPPH 3274. B737-700 10816.7 34072.8 10
Price
R.F.I.
Fuel &
Current
1
select a save point from a group below ...
click here to clear filter...
By 500km Circles - (21)
By PAX - (2)
By To And From - (142)

**Figure 95 Carbon Counter Interface - By PAX Save Point (showing parent)**

When selecting the 'By PAX' group as shown in this example the flights are broken into two Save Points – Domestic and International categories (in the example dataset there are 17,881 domestic movements and 4,055 international movements). The currently applied filter can be cleared by selecting the line with the message **click here to clear filter...** **[1]**. The list of all Save Point groups can be returned to by selecting the **..** line **[1]**. Depending upon the Save Point group originally selected the last two entries in this example will be replaced by one or more other entries

relevant to the Save Point group selected. When, for example, **International** is selected the program automatically generates a filtered carbon count for international movements (as specified in the Save Point) and displays this in the boxes next to the total carbon count – this example is shown in ***Figure 96***. The filtered data is shown in the area at **[1]**.

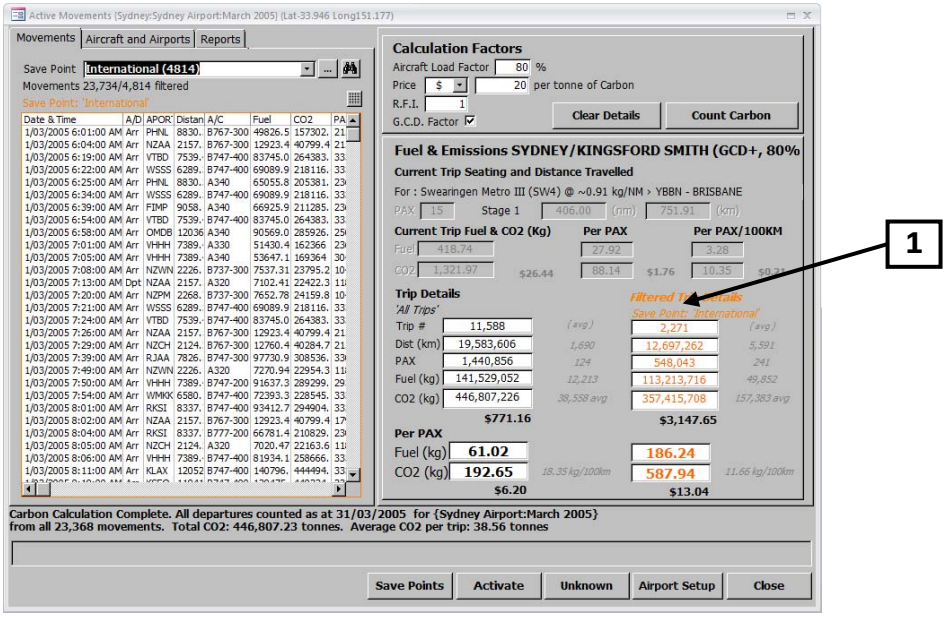



**Figure 96 Display comparing total and international operations**

This enables the user to rapidly see the contribution that international operations made to the total carbon footprint during the period covered by the dataset using a number of different parameters (i.e. trips, passengers, fuel, etc).

## 11.5 The Reports Tab

Selecting the **Reports** tab on the **Active Movements** interface **[1]** brings up the screen at ***Figure 97***. This screen has four key areas: the **metrics** area **[A]**, the **data selection** areas **[B]** & **[E]**, the **graphics** area **[C]** and the **data** area **[D]**.

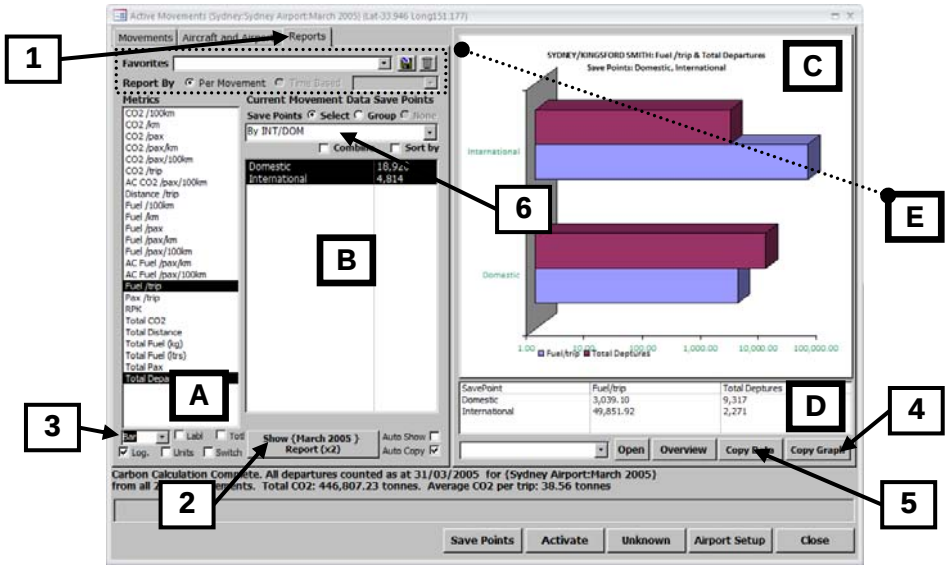



**Figure 97 Carbon Counter (Reports tab) interface**

**Metrics Area** **[A]** – this area contains a listing of different metrics for examining the data in the selected dataset or sets. One or any number of the metrics can be selected using the mouse and the control and shift keys. When the user initially opens this tab the metrics operate on the active dataset – other datasets can be used, and comparisons between datasets can be made, through the data selection area.

**Data Selection Area** **[B]** & **[E]** – Once a data grouping has been selected computation is initiated by pressing the Show Report button Show {March 2003} Report (x2) at **[2]** with the resulting report shown in the graphics area **[C]**.

**Graphics Area** **[C]** – this area gives a graphical display of the results of the computation where the selected metric(s) have been applied to the selected data. The form of the graphic can be presented in a number of ways (e.g. bar, column, line and pie charts; logarithmic or linear) by selecting from the drop down list and boxes at **[3]**. When the program has generated a graphic it may be exported to other programs by selecting the Copy Graph button **[4]** – this places the graphic on the clipboard which then lets the user for example, paste it into a report being generated in Microsoft Word.

**Data Area** – **[D]** - this area contains the data which underlies the graphic at **[C]**. All the metrics selected in **[A]** is displayed in **[D]**. This data can be exported to another program by selecting the Copy Data button **[5]**, in a similar manner to the graphics area Copy Graph button, the data is placed on the clipboard to facilitate its use in other programs.

### 11.5.1 Reporting – Using The Active Dataset

When the program is opened on the reports tab the dataset being reported on is, by default, the active dataset. Any selection made in the metrics area **[A]** will produce a graphic using data from that dataset.

Subsets of that dataset can be used, in a similar manner to the movements tab, by first selecting a group from the drop down at **[6]** and then selecting one or more Save Points from the list at **[B]**. This list of Save Points contains the same Save Points that are shown on the movements tab (see **[6]** of ***Figure 91***). The Movements tab displays the Save Point groups and their related Save Points into a single control, however, on the Report tab these two items have been split into two controls. The user can make multiple selections from **[B]** by using the control and shift keys in the usual way. Once the selections have been made the *Show Report* button Show {March 2003} Report (x2) is selected and the program then computes and displays the graphic in area **[A]** and the data in area **[B]**.

An example where the user has selected two metrics to cross compare between eight selected Save Points from the *By To And From* Save Point group for the current active movements (March 2003) is shown in ***Figure 98***.

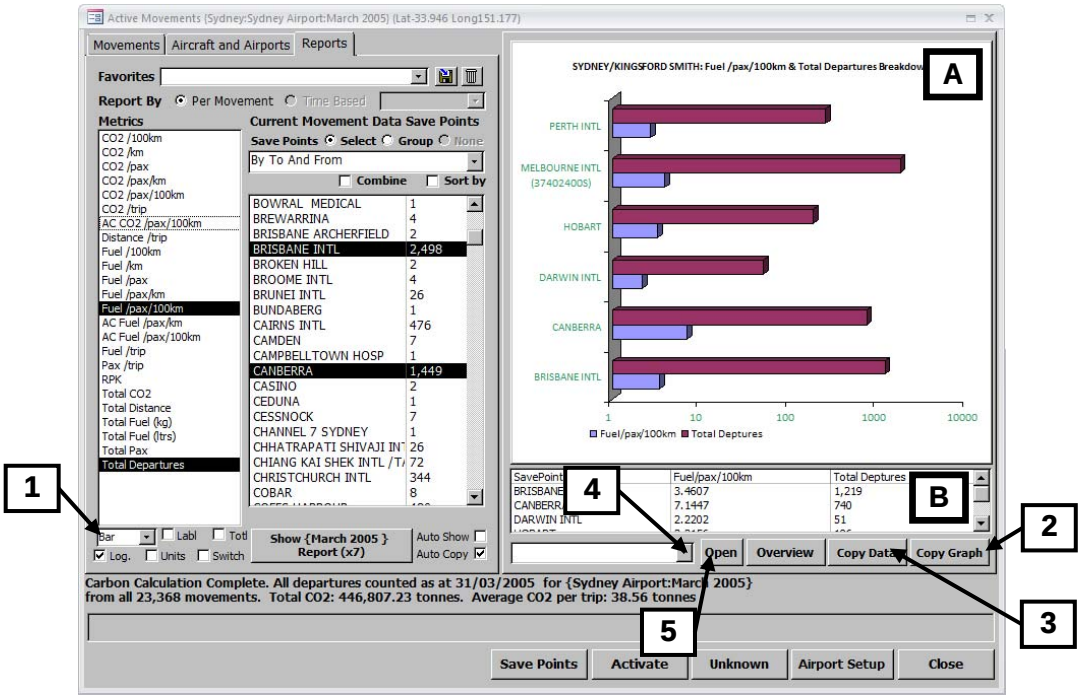



**Figure 98 Example Carbon Counter Fuel & Departure report (three selected Save Points visible)**

Despite seven Save Points being selected, as indicated by (x7) on the Show {March 2005 } Report (x7) button, there are only six locations displayed in the graph **[A]** as one of the Save Points does not meet the required reporting criteria.

Selected items will be missing from the graphic **[A]** and data area **[B]** when a movement falls under one or more of the following conditions:

- The movement is not a departure.
- The arrival/departure airport is undefined.
- The aircraft is undefined.
- Carbon has not been counted, is out of date, invalid or previously interrupted and needs to be recounted.
- The fuel usage for the movement has been calculated to be nil because of zero distance or fuel burn.

## Embedded Reports

The program also contains a number of embedded reports which can be generated by selecting from the drop down line list at **[4]** or by using the Open Report button at **[5]** on the Reports tab interface (***Figure 98***) – an example chart is shown in ***Figure 99***.

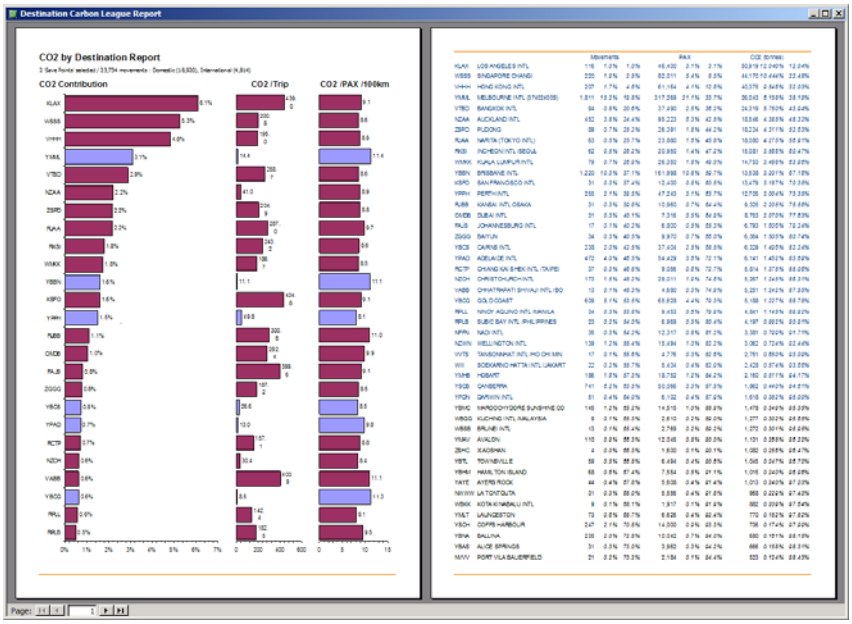



**Figure 99 Destination Carbon League Report - 2 page view**

This example shows the **Destination Carbon League** report. It shows a bar chart for fuel use (and related data) for international (maroon) and domestic (blue) destinations ordered by magnitude. The accompanying table shows the underlying data and indicates the routes which make up 95% of the fuel use for the active airport. There is a similar report – the **Aircraft Carbon League** report – which provides parallel information for aircraft types.

# Part V

# Technical Appendix

# Chapter 12

# Worked Examples

This part demonstrates six simple examples of how TNIP Carbon Counter may be used.

## 12.1 Example 1: Examining a Policy Option - Short/Long haul

There has been extensive debate in recent times in the media, particularly in Europe, about whether restrictions should be placed on the use of aviation for short haul flights since, on a per passenger basis, these flitghts may be less fuel efficient thant alternative forms of transport such as road and rail. For the purposes of these discussions 'short haul' has commonly been defined as flights travelling a distance of 500km or less. TNIP Carbon Counter enables the user to rapidly see what would be the carbon, and traffic, implications of removing short haul flights from an airport.

Using the embedded Save Point for '500km circles', or by generating another Save Point with a different user defined circle distance (see ***Chapter 7***), the user can filter out flights within a certain distance and compare the fuel use/$CO_2$ generated between short haul and other traffic.

The image in ***Figure 100*** shows a sample for Sydney Airport using the embedded dataset. A filtered dataset has been generated for all flights that were less than 500km and the fuel/$CO_2$ implications can be viewed by comparing the information in areas **[A]** and **[B]**. This shows that for Sydney Airport for the month of March 2005 approximately 30% of the flights departing from the Airport travelled a distance of 500km or less and that they generated approximately 1.4% of the total $CO_2$ generated by aircraft movements at the Airport in that month. Thus even if it were feasible to transfer all short haul aviation passengers to rail and/or road transport, the impact on the overall carbon footprint would be small.

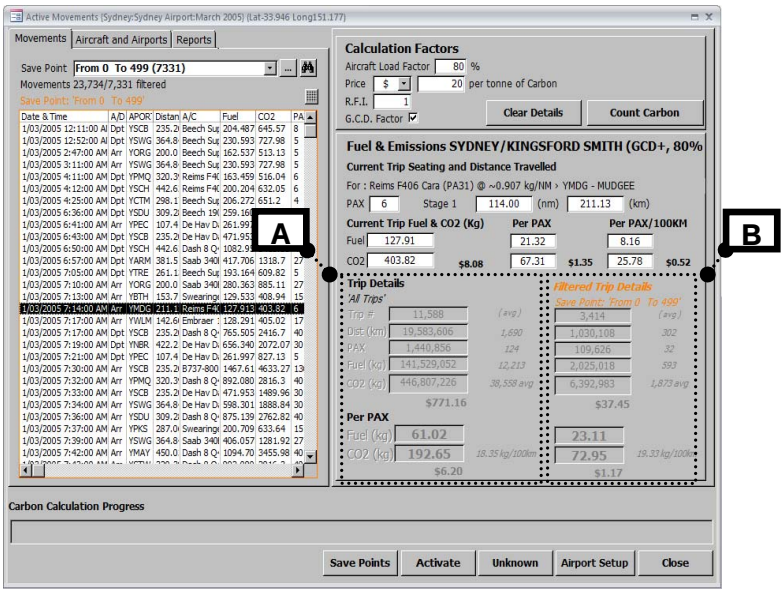



**Figure 100 Example showing short haul carbon footprint contribution**

## 12.2 Example 2: Environmental Reporting – Tracking change over time

Trend reporting of any form of pollution is a fundamental component of environmental management. Much of the debate on climate change, and many of the commitments to action, involves implementing strategies which reduce a sector's carbon footprint over time. Trend reporting aviation's temporal carbon footprint is very important if there is to be public confidence in the aviation industry's response to climate change.

The capability to examine trends over time is a key feature of TNIP Carbon Counter. The sample image in ***Figure 101*** shows trends in the annual fuel consumption and the average fuel efficiency (expressed in kg of fuel/passenger/100km) for international departures at Sydney Airport over the 11 years from 1999 to 2009. The results indicate a general increase in fuel use (blue bars) but a decrease in the fuel intensity (red line) over the years. These results were extracted from the Reports tab of the Network Carbon Overview window in TNIP Carbon Counter. Similar trend reports can be generated for the full range of metrics contained in the Reports tab across any of the datasets contained in the Vault.

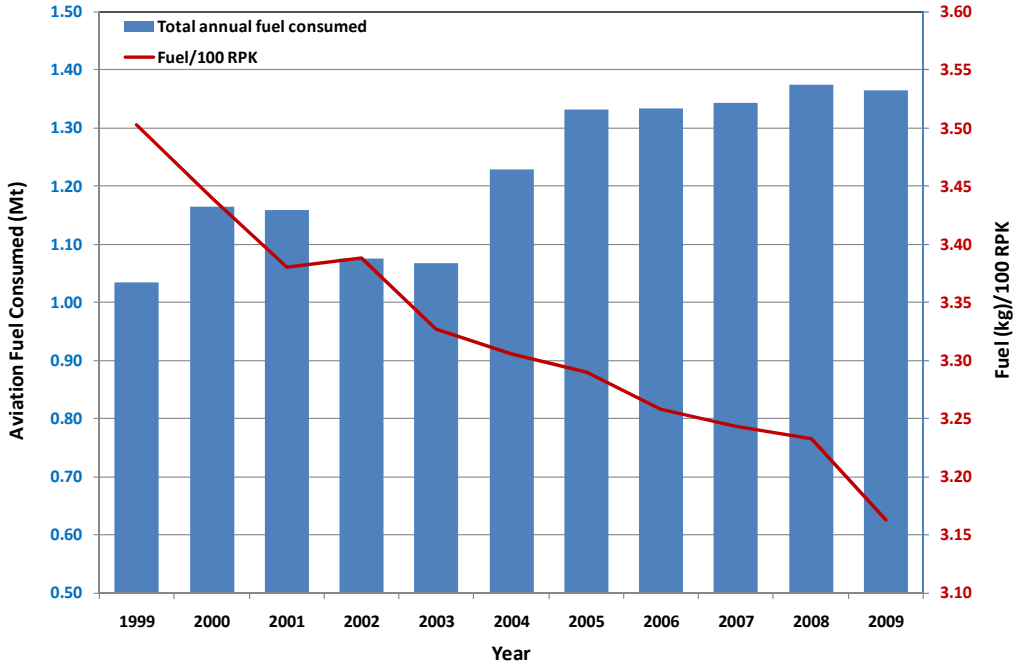



**Figure 101 Changes in annual fuel consumption and average fuel efficiency for international aircraft operations at Sydney Airport.**

## 12.3 Example 3: Environmental Impact Assessment (EIA)

Conventionally environmental assessment of proposed developments in the aviation sector, for example, a project to construct a new runway, have not included examination of the carbon implications of proceeding with a project. However, it is highly likely that in future all major projects (in all sectors, not just aviation) undergoing EIAs will be required to include an assessment of climate change impacts.

TNIP Carbon Counter is well suited to carrying out these assessments as it uses the same time-stamped aircraft movement datasets for carbon assessment as those used for aircraft noise assessment when performing aircraft noise analyses using tools in the TNIP family of software.

Environmental assessment of aircraft noise using time-stamped aircraft movement datasets emerged in response to public demands for more transparent approaches to aircraft noise assessments. These approaches facilitate the examination of noise exposure that goes beyond the conventional annual average day analysis - these enable variations in noise exposure patterns (e.g. from day to day or season to season) to be clearly identified and transparently reported.

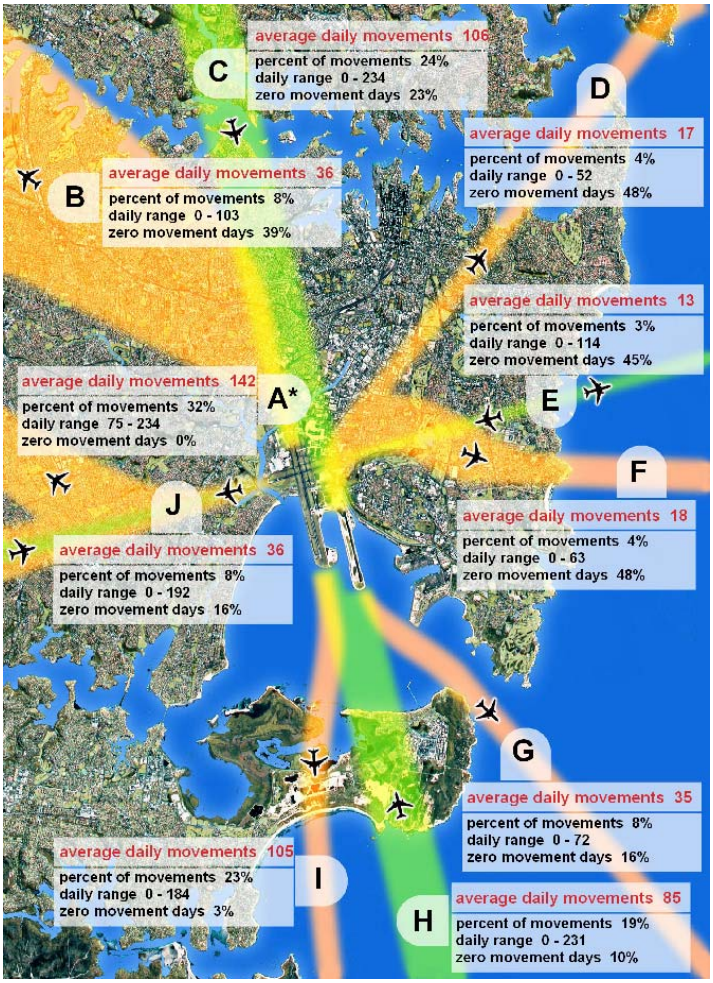



**Figure 102 Flight path movements chart for Sydney Airport March 2003**

The flight by flight datasets which underpin the TNIP noise analyses contain all the information that is required to carry out great circle based carbon computations (see ***Section 5.2***). Importantly, working with a disaggregated movement by movement dataset allows the user to carry out

detailed analysis of the projected carbon footprint broken down into subsets (e.g. domestic vs international; interstate vs intrastate; short haul vs long haul; impacts of fleet renewal; etc)

The image in ***Figure 102*** shows the flight path movements chart for Sydney Airport for March 2003 generated using a similar one month aircraft movements dataset that is bundled with the downloadable TNIP Carbon Counter demonstration package.
The image was produced using TNIP Expert:
http://www.infrastructure.gov.au/aviation/environmental/transparent_noise/tnip_core.aspx).
Aircraft movement data files for past periods can be extracted from airport/ANSP operations databases.

Future datasets, such as those that are used in an EIS process, can be constructed through use of projected airport schedules for a future year. A simplified approach can be to take the projected schedule for a 'typical' and/or 'busy' day, and use this to build up a dataset for a future year (i.e. replicate the day 365 times). This type of approach was used in the EIS for the new parallel runway at Brisbane Airport. In this EIS four typical days were constructed for each future year (northern winter – weekday & weekend; northern summer – weekday & weekend) and these were then used to build up a detailed aircraft movement schedule for each of a number of future years. This approach is described in the document at:
http://www.newparallelrunway.com.au/files/pdf/D4.pdf.

## 12.4 Example 4: Examining Improved Fuel Efficiency

A likely scenario that the user may want to examine is the carbon footprint impacts of replacing specific aircraft types with more fuel efficient alternatives. For example, what would happen if all the B767s and B777s operating on a route were replaced with B787s? In the absence of any fuel data for the B787, scenario runs could be carried out – say runs at 10%, 15% and 20% greater fuel efficiency for the B787 compared to the other aircraft types.

These scenarios can be run by generating new fuel use data for the B767 and B777 and substituting this in the fuel burn table for those aircraft types. It is probably simplest to generate the new datasets in Microsoft Excel and then paste the data into the fuel use column in the 'Enroute Fuel Burn' interface (see ***Subsection 3.3.4***).

The example below examines the carbon implications of substituting B767 and B777 aircraft with B787 aircraft for a sample aircraft movements dataset – movements at Sydney Airport for the month of March 2005. The EMEP/CORINAIR dataset contains fuel use data for B767 and B777 aircraft but not for the B787. In order to account for this a synthetic fuel burn category can be created. For the purposes of this example a new hypothetical generic aircraft type – 'B767& B777' - has been generated using the EMEP/CORINAIR fuel burn data for the B767-300ER. An assumption is made that the B787 is 10% more efficient than the new synthetic aircraft type. ***Figure 103*** shows the unadjusted fuel burn data for the 'B767&B777'; ***Figure 105*** shows the updated data for the 'B767&B777' using 10% less fuel (i.e. simulating the B787).

Using this approach all references to 'B767' and 'B777' in the aircraft movements dataset are replaced by the text 'B767&B777' before the movements file is loaded into TNIP Carbon Counter and the CO2 computations are carried out. The first run uses the unadjusted fuel burn profile to generate the data in *Figure 105* while the second run uses the adjusted fuel burn profile to generate the data in ***Figure 107.*** Comparison between ***Figure 104*** and ***Figure 106*** shows that for the month of March 2005 at Sydney Airport, if the hypothetical aircraft substitution had taken place, about 1,170 tonnes less fuel would have been burnt in total across all departures from the airport (on a per passenger basis a drop from 56.48kg/PAX to 55.60kg/PAX).

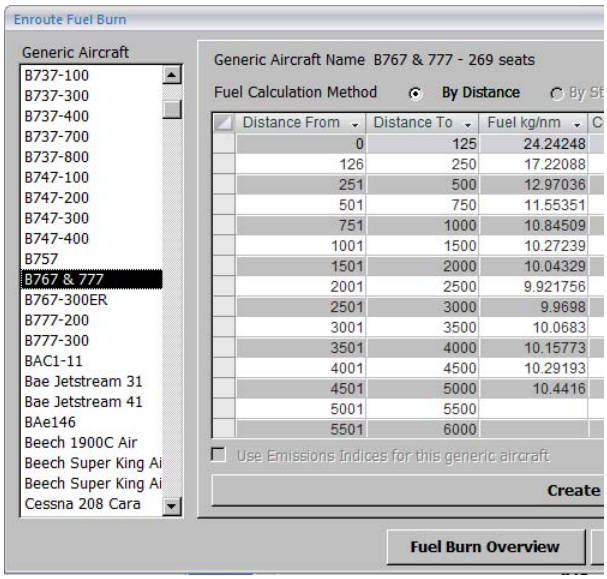



**Figure 103 'B767's & B777's'**
**using standard CORINAIR fuel data for the B767**

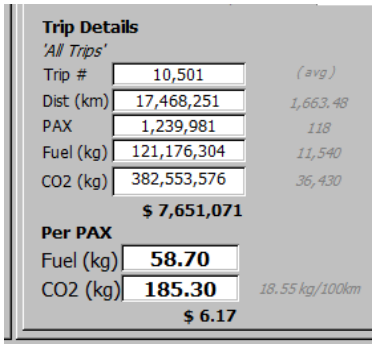



**Figure 104 Carbon count – 'B767 & B777'**
**unadjusted fuel use**

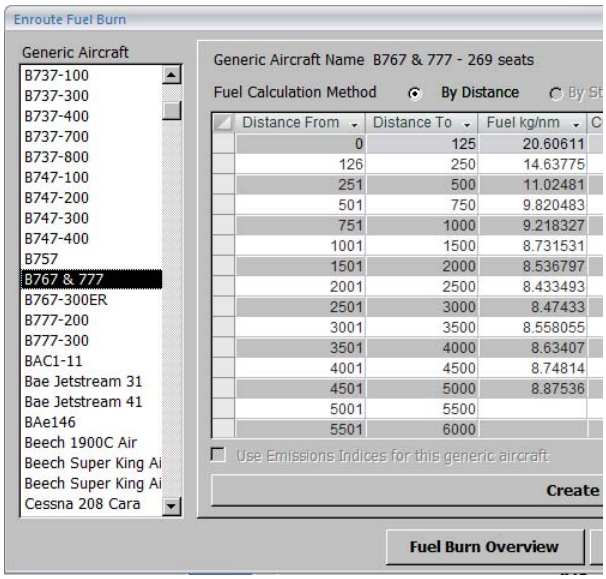



**Figure 105 'B767's & B777's'**
**with standard B767 fuel burn less 10%**

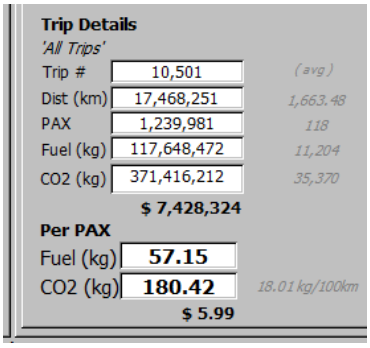



**Figure 106 Carbon count - 'B767 & B777'**
**fuel use reduced by 10%**

## 12.5 Example 5: Network Carbon Footprinting

TNIP Carbon Counter gives the user the ability to rapidly interrogate large databases containing information on aviation system aircraft movements. The filtering tools enable the user to generate multiple user defined subsets of the main datasets – reports can then be generated from the data subsets using a range of metrics through either using internal program capabilities or exporting the data. These functions are contained in the **Queries & Reports** interface described in *Section 8.2*.

At the present time there are no standard accepted formats for footprint reporting of aircraft operations and a range of footprinting concepts are now being tested. *Figure 107* to *Figure 110* are examples of different formats that are being trialled to show the carbon footprint for aircraft departures originating in Australia for the financial year 2008-09.

*Figure 107* and *Figure 108* are based on subsets of the aircraft movements dataset for Australia for the 2008-09 financial year generated using the **State of Destination** Save Point (see *Subsection 7.6.7*). The data subsets were exported to Microsoft Excel and the values of the reported metrics were computed using published energy conversion factors and a hypothetical cost of carbon at $20 per tonne.

These diagrams are designed to provide the viewer with a rapid appreciation of the relative contributions of different routes/regions to the total carbon footprint for international departures from Australia.

Figure 107 and Figure 108 were generated using 'e!sankey' - a graphics program used to generate quantity flow diagrams (http://www.e-sankey.com/en/).

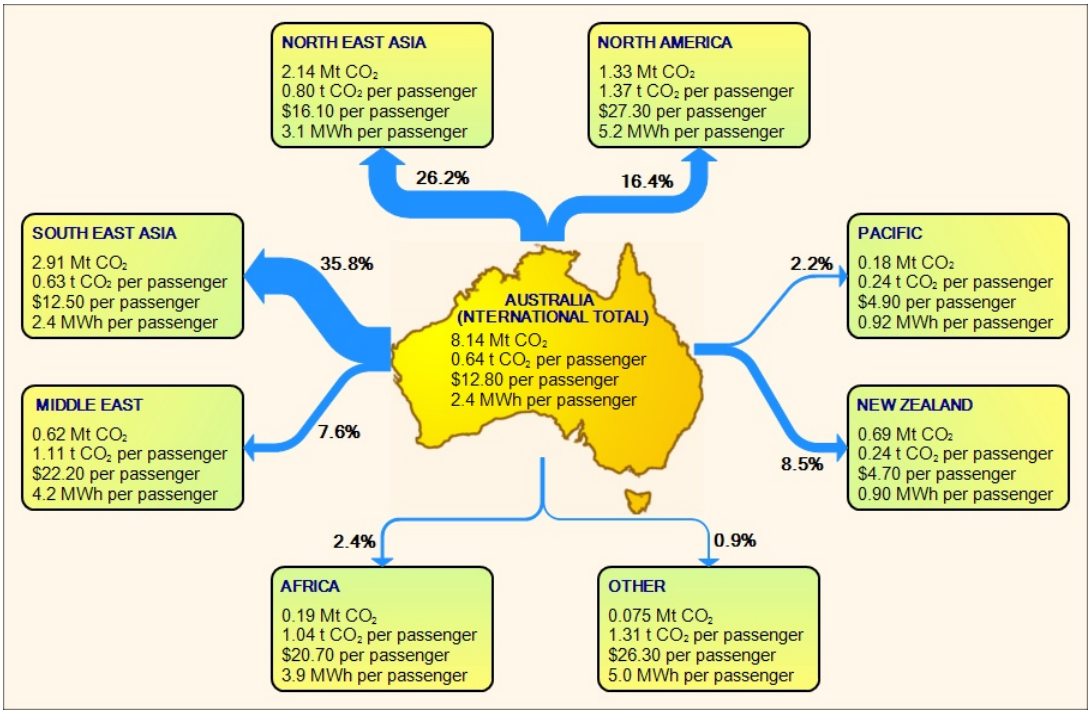



**Figure 107 Australia's annual aviation carbon emissions from international departures, 2008-09**

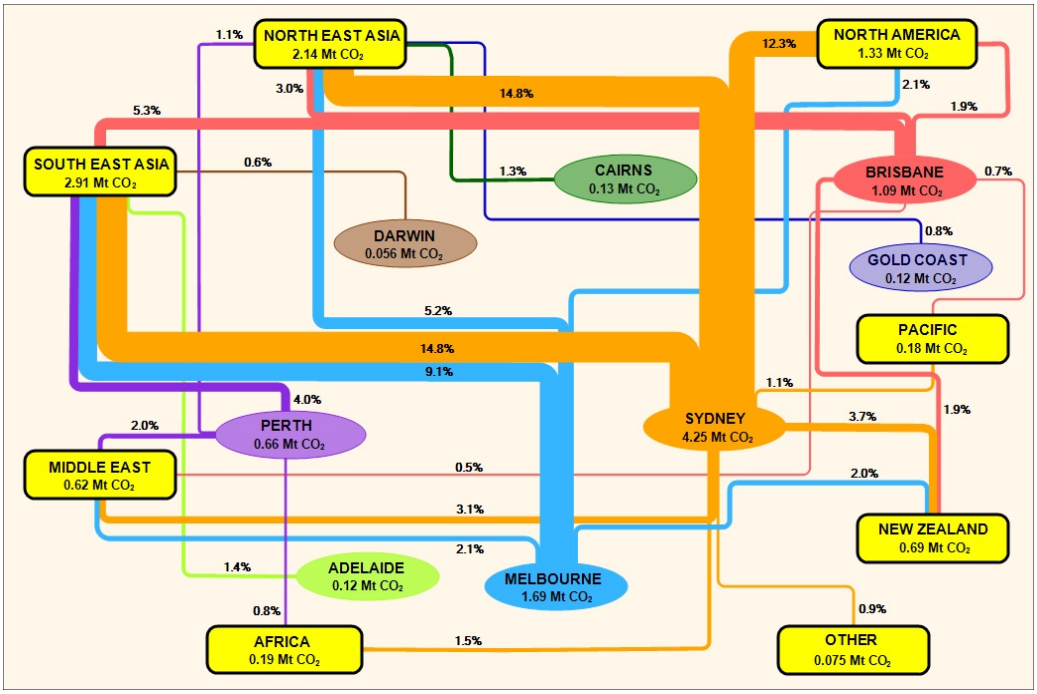



**Figure 108 Carbon emissions from international departures from Australia's international airports, 2008-09**

The donut diagram in ***Figure 109*** was computed using the State of Origin Save Points (see ***Subsection 7.6.7***) This simple diagram, a standard Microsoft Excel graphic, provides a good picture of the differences in composition of the aircraft operation carbon footprints for each of the Australian States and Territories. Aggregating the data by Save Points is described in ***Subsection 8.3.3***.

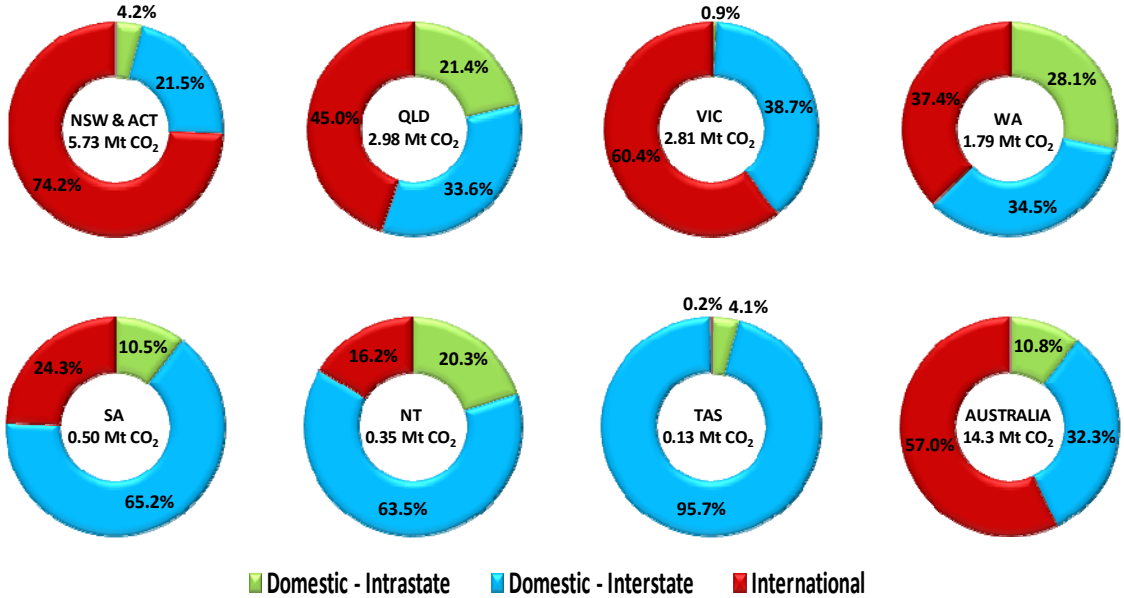



**Figure 109 Contributions to the carbon footprint of Australia's states from intrastate, interstate and international aircraft departures, 2008-09**

Conventional bar graphs can be an effective means of showing comparisons between city pair carbon footprints. The data in ***Figure 110*** was generated using the **City Pair** Save Point (see ***Subsection 7.6.7***).

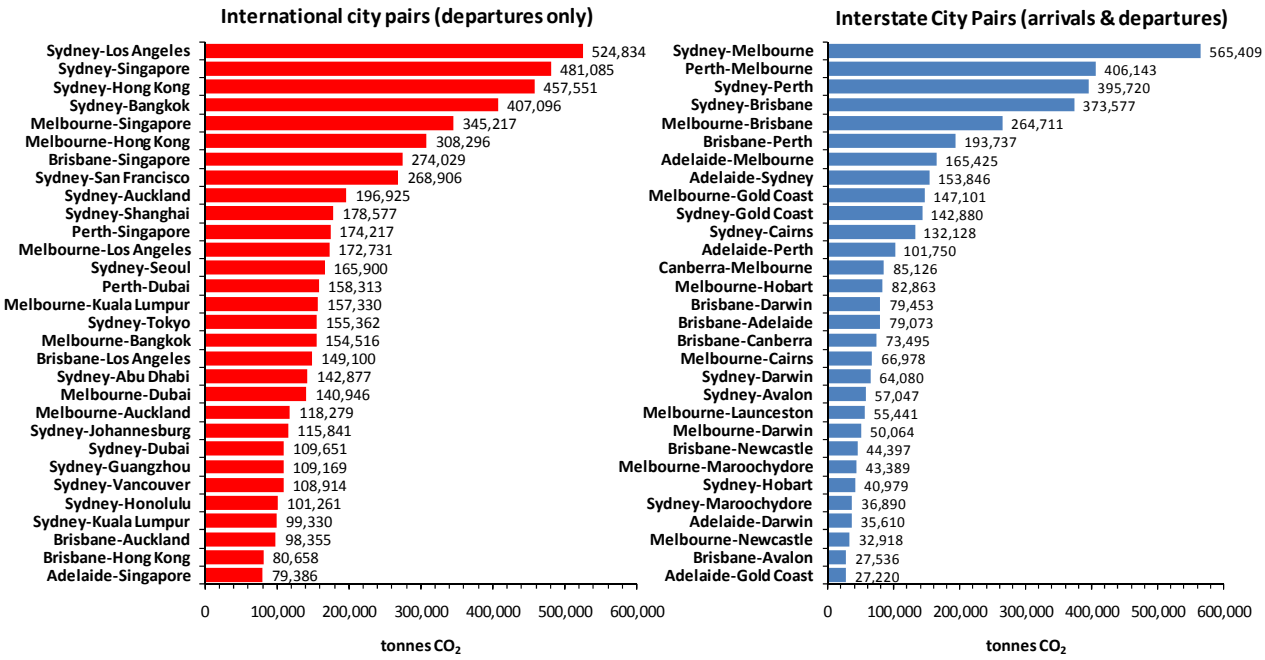



**Figure 110 Australia's top 30 international and domestic aviation routes in terms of $CO_2$ emissions, 2008-09**

## 12.6 Example 6: Corporate Footprinting

An example of the type of information on corporate emissions that can be computed from employee travel records is shown below. This example uses the sample corporate movements data file for a hypothetical company shown in ***Figure 79*** (***Section 9.2)***.

As discussed in ***Chapter 9***, the data file includes two user-defined **Extras** Save Points called **DIVISION** and **EMPLOYEE** which enables the company's carbon emissions to be analysed according to these categories. ***Figure 111*** shows the results in the **Queries & Reports** window after processing the data file.

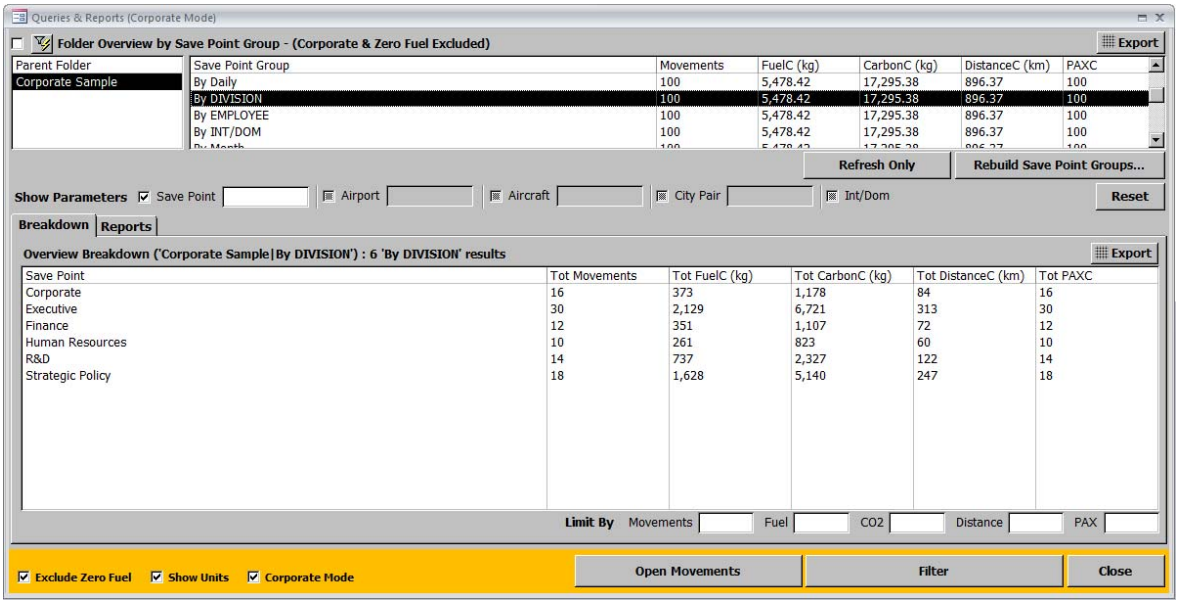

Queries & Reports (Corporate Mode)
Folder Overview by Save Point Group - (Corporate & Zero Fuel Excluded)
Export
Parent Folder
Corporate Sample
Save Point Group | Movements | FuelC (kg) | CarbonC (kg) | DistanceC (km) | PAXC
By Daily | 100 | 5,478.42 | 17,295.38 | 896.37 | 100
By DIVISION | 100 | 5,478.42 | 17,295.38 | 896.37 | 100
By EMPLOYEE | 100 | 5,478.42 | 17,295.38 | 896.37 | 100
By INT/DOM | 100 | 5,478.42 | 17,295.38 | 896.37 | 100
Refresh Only
Rebuild Save Point Groups...
Show Parameters
Save Point
Airport
Aircraft
City Pair
Int/Dom
Reset
Breakdown
Reports
Overview Breakdown ('Corporate Sample|By DIVISION') : 6 'By DIVISION' results
Export
Save Point | Tot Movements | Tot FuelC (kg) | Tot CarbonC (kg) | Tot DistanceC (km) | Tot PAXC
Corporate | 16 | 373 | 1,178 | 84 | 16
Executive | 30 | 2,129 | 6,721 | 313 | 30
Finance | 12 | 351 | 1,107 | 72 | 12
Human Resources | 10 | 261 | 823 | 60 | 10
R&D | 14 | 737 | 2,327 | 122 | 14
Strategic Policy | 18 | 1,628 | 5,140 | 247 | 18
Limit By
Movements
Fuel
CO2
Distance
PAX
Exclude Zero Fuel
Show Units
Corporate Mode
Open Movements
Filter
Close

**Figure 111 Corporate Movement Data for a hypothetical company**

The bottom half of the window in ***Figure 111*** shows the total movements, total fuel, total carbon, average distance travelled per employee and total number of employees for each of the company divisions listed under the **DIVISION** heading in the movements data file.

Using the data above, the column graph in ***Figure 112*** plots the total carbon emissions and the average carbon per **employee** by **division** for the hypothetical company. This is a very simple example of the type of graphic that can be used to portray a corporate aviation travel carbon footprint – clearly a very wide range of parameters can be selected, and graphical and tabular representations shown, to report the carbon footprint of aviation travel by employees of an organisation.

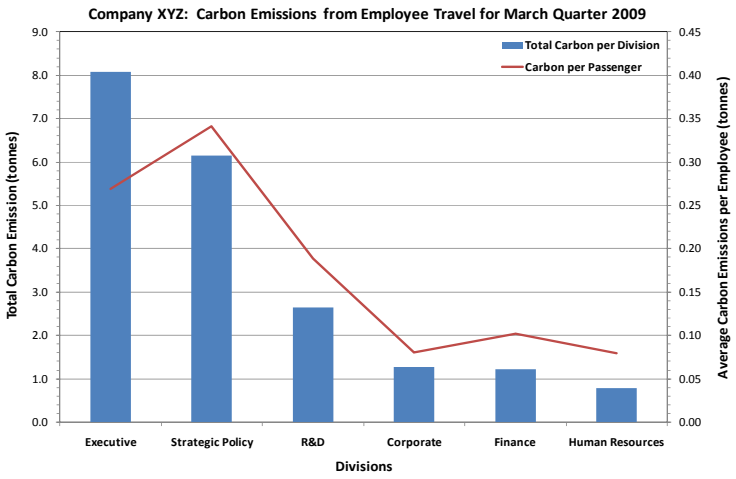



**Figure 112 Carbon Emissions by Division for a hypothetical company**

# Chapter 13

# Validation

## 13.1 Introduction

Carbon footprinting of aviation is in its infancy and there is still much debate about the accuracy of currently available methodologies. In December 2007 ICAO's Committee on Aviation Environmental Protection (CAEP) established a group to work on the development of a carbon calculator.[1] This work had been initiated by the ICAO Secretariat earlier in 2007. This group, which was termed the ACE (Aviation Carbon Estimation) group, was chaired by IATA and became a focal point for international discussion on carbon calculation methodologies.

Australia was a member of the ACE group and TNIP Carbon Counter has adopted key elements of the work of that group. In particular the group, while recognising several shortcomings in the EMEP/CORINAIR dataset, determined that it is the most appropriate publicly available dataset to use at the present time for computing the carbon footprint of aircraft operations between two specified airports. Given the agreement within the ACE group, TNIP Carbon Counter uses the EMEP/CORINAIR dataset as its computation 'engine'.

## 13.2 Potential Sources of Error

**Great circle computation** – in common with most carbon footprinting tools, TNIP Carbon Counter computes the distance between any two airports using Great Circle Distances (GCD). This is clearly an approximation which doesn't take into account indirect routing, holding, etc. The IPCC recommends adding a 9% increment to the Great Circle Distance in carrying out carbon computations in order to take account of the additional track miles that are incurred in practice. The IPCC adjustment factor was examined by the ACE group and it was agreed that more accurate results would be obtained if the variable adjustments in the following table are used.

| GCD | Correction to GCD |
|---|---|
| Less than 550 km | + 50 km |
| Between 550 km and 5500 km | + 100 km |
| Above 5500 km | + 125 km |

These variables are used in the ICAO Carbon Calculator and also in TNIP Carbon Counter.

**Seat Numbers** – the program only facilitates the user entering one figure for the number of seats for a particular aircraft type. This is an approximation in that different carriers configure their aircraft with different seat layouts and hence this will induce inaccuracies in 'per passenger' computations. It is not clear at this stage whether this is a significant issue. It would be possible to refine the program to use operator specific seat numbers if this were found to be a significant source of error. The seat numbers for each aircraft type in TNIP Carbon Counter were sourced from Wikipedia.

[1] ICAO Carbon Emissions Calculator (http://www2.icao.int/en/carbonoffset/Pages/default.aspx).

**Load factors** – the program only lets the user enter one load factor for each computation – this is likely to lead to errors in 'per passenger' computations. It is recognised that restricting the load factor to one global value is an approximation as load factors can vary widely by route and by time. Ideally the program should facilitate the selection of multiple load factors across datasets to enable load factors to vary, for, example, over time, by route, by international/domestic, day of week, season of year, etc.

**Freight vs passengers** – prolonged discussion took place within the ACE group about computing the amount of fuel on any flight that can be ascribed to passengers as opposed to that which should be apportioned to freight carried in the belly of aircraft. In line with the comments on seat numbers, it is not clear at this stage how significant an issue this is.

**EMEP/CORINAIR data** – while this is generally accepted as the best publicly available fuel use dataset it does have important limitations. In particular the CORINAIR dataset does not have fuel use data for the A380 or B737-700 and B737-800 aircraft which are now very common aircraft. In TNIP Carbon Counter the CORINAIR dataset has been expanded to include an A380 fuel burn profile which uses 10% less fuel than a B747. Similarly the CORINAIR dataset was also expanded to include the fuel burn profiles of B737-700 and B737-800, both of which were set to use 20% less fuel than the B737-400.[2] The CORINAIR dataset also has a limited number of aircraft types, so the user has to make a number of aircraft substitutions. Estimates of aircraft fuel burn profiles are also provided by Eurocontrol's free Small Emitters Tool.[3]

## 13.3 Validation

### 13.3.1 Aviation fuel usage – Australian network

Computed monthly jet fuel (avtur) usage for the entire Australian network (both domestic and international) has been compared with actual fuel sales for the financial year 2008-09 as reported in the *Australian Petroleum Statistics*.[4] The results are shown in Table 1.

Points to note about Table 1:

- The actual fuel sales data has been reduced by 8% to account for military usage. This is the same assumption used in the *National Greenhouse Gas Inventory 2007* for allocating avtur fuel consumption to military operations.[5]
- The results below show that for all months except March and June 2009 the computed fuel usage differed by less than 5% from the actual fuel sales. For March and June 2009 the computed results differed in magnitude by just over 7% from the actual monthly fuel sales. For most months TNIP Carbon Counter underestimated the fuel usage. Monthly discrepancies between computed and actual data can be due to a number of factors. For example, the pattern of military fuel usage is unknown and is likely to vary from the

[2] This assumption was based on modelling of narrow-bodied and wide-bodied aircraft by Daniel Rutherford, a senior researcher at the International Council on Clean Transportation (ICCT) (http://www.flightglobal.com/articles/2009/06/29/328868/mapping-carbon-emission-improvements.html).

[3] EUROCONTROL Small Emitters Tool (http://www.eurocontrol.int/articles/small-emitters-tool).

[4] *Australian Petroleum Statistics*, Australian Government Department of Resources, Energy and Tourism (http://www.ret.gov.au/resources/fuels/aps/Pages/default.aspx).

[5] *National Greenhouse Gas Inventory 2007*, Volume 1, Part A, Table 3.A12, page 102 (http://www.climatechange.gov.au/en/publications/greenhouse-acctg/national-inventory-report-2007.aspx).

constant 8% of total fuel sales as assumed here. Also excess fuel could be purchased in one month and not be used until subsequent months.

- For the financial year 2008–09 the computed annual total was 2.2% less than the actual fuel sales. This level of agreement would appear to indicate that the computational algorithms underlying TNIP Carbon Counter (essentially the algorithms in the ICAO Carbon Calculator) are robust when applied to flight operations spanning a wide network and long period of time.

| Month | Avtur (megalitres) | | | Cumulative monthly avtur totals (megalitres) | | |
|---|---|---|---|---|---|---|
| | Sales (less 8% military) | TNIP (computed) | Difference (%) | Sales (less 8% military) | TNIP (computed) | Difference (%) |
| Jul 2008 | 494.841 | 476.825 | -3.6 | 494.841 | 476.825 | -3.6 |
| Aug 2008 | 481.928 | 467.576 | -3.0 | 976.770 | 944.402 | -3.3 |
| Sep 2008 | 475.186 | 452.660 | -4.7 | 1,451.955 | 1,397.062 | -3.8 |
| Oct 2008 | 481.288 | 474.593 | -1.4 | 1,933.243 | 1,871.655 | -3.2 |
| Nov 2008 | 470.908 | 461.396 | -2.0 | 2,404.151 | 2,333.050 | -3.0 |
| Dec 2008 | 497.564 | 481.897 | -3.1 | 2,901.715 | 2,814.948 | -3.0 |
| Jan 2009 | 478.787 | 474.407 | -0.9 | 3,380.502 | 3,289.355 | -2.7 |
| Feb 2009 | 424.707 | 426.307 | 0.4 | 3,805.209 | 3,715.661 | -2.4 |
| Mar 2009 | 441.433 | 473.422 | 7.2 | 4,246.642 | 4,189.083 | -1.4 |
| Apr 2009 | 483.608 | 465.098 | -3.8 | 4,730.250 | 4,654.181 | -1.6 |
| May 2009 | 469.916 | 452.957 | -3.6 | 5,200.166 | 5,107.138 | -1.8 |
| Jun 2009 | 478.899 | 445.086 | -7.1 | 5,679.064 | 5,552.225 | -2.2 |

**Table 1: Australia's jet fuel (AVTUR) usage, 2008–09**

**Note:** This table was published in Information Paper IP/41 that was presented by Australia at the CAEP/8 meeting in Montreal in February 2010. The numbers in this table were based on preliminary estimates of fuel usage for the A380, B737-700 and B737-800 aircraft. These figures have since been refined to the values discussed in Section 12.2. Re-working of the data gives a difference between the computed and 'actual' cumulative total for the year July 2008 - June 2009 of -1.0% compared to the figure of -2.2% as shown in the table.

### 13.3.2 Air passengers – Australian network

Table 2 compares the computed monthly passengers for 2008–09 for the entire Australian network with scheduled passenger movements published by BITRE.[6]

[6] BITRE *Monthly Airline Performance* (http://www.bitre.gov.au/info.aspx?ResourceId=225&NodeId=101).

| Month | Passenger movements (departures only) | | | | | | Difference (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Actual (scheduled services only) | | | TNIP (computed) | | | | | |
| | Domestic | International | Total | Domestic | International | Total | Domestic | International | Total |
| Jul 2008 | 4,365,292 | 980,606 | 5,345,898 | 4,681,356 | 1,076,400 | 5,757,756 | 7.2 | 9.8 | 7.7 |
| Aug 2008 | 4,199,095 | 980,102 | 5,179,197 | 4,464,433 | 1,079,633 | 5,544,066 | 6.3 | 10.2 | 7.0 |
| Sep 2008 | 4,192,995 | 938,860 | 5,131,855 | 4,507,041 | 1,046,142 | 5,553,183 | 7.5 | 11.4 | 8.2 |
| Oct 2008 | 4,530,367 | 904,177 | 5,434,544 | 4,893,995 | 1,000,474 | 5,894,469 | 8.0 | 10.7 | 8.5 |
| Nov 2008 | 4,168,157 | 947,361 | 5,115,518 | 4,448,392 | 1,050,735 | 5,499,126 | 6.7 | 10.9 | 7.5 |
| Dec 2008 | 4,189,226 | 1,165,534 | 5,354,760 | 4,500,314 | 1,276,153 | 5,776,466 | 7.4 | 9.5 | 7.9 |
| Jan 2009 | 4,182,024 | 1,027,876 | 5,209,900 | 4,450,397 | 1,109,429 | 5,559,826 | 6.4 | 7.9 | 6.7 |
| Feb 2009 | 3,642,560 | 825,526 | 4,468,086 | 3,949,033 | 911,482 | 4,860,515 | 8.4 | 10.4 | 8.8 |
| Mar 2009 | 4,186,274 | 936,476 | 5,122,750 | 4,494,672 | 1,030,806 | 5,525,478 | 7.4 | 10.1 | 7.9 |
| Apr 2009 | 4,165,642 | 1,006,849 | 5,172,491 | 4,443,186 | 1,101,325 | 5,544,511 | 6.7 | 9.4 | 7.2 |
| May 2009 | 3,963,769 | 924,617 | 4,888,386 | 4,224,442 | 996,568 | 5,221,010 | 6.6 | 7.8 | 6.8 |
| Jun 2009 | 3,817,699 | 978,230 | 4,795,929 | 4,105,128 | 1,058,606 | 5,163,734 | 7.5 | 8.2 | 7.7 |
| **ANNUAL** | **49,603,100** | **11,616,214** | **61,219,314** | **53,162,388** | **12,737,752** | **65,900,140** | **7.2** | **9.7** | **7.6** |

**Table 2: Australia's air passenger movements, 2008–09**

Points to note about Table 2:

- The load factors used in TNIP Carbon Counter for computing domestic and international passenger movements were the actual monthly averaged load factors for the respective sectors as published by BITRE.
- For 2008–09 the computed results were higher by 7.8% and 9.8% for the domestic and international sectors respectively when compared to the actual scheduled passenger movements. The computed number of passenger movements is always likely to be higher than the published scheduled traffic because the data provided by Airservices Australia includes non-scheduled services, some military movements and dedicated cargo flights. There is no indication in the Airservices data as to which aircraft movements are dedicated freighters. TNIP Carbon Counter assigns the same number of seats to these flights as for passenger flights, thereby increasing the computed results.
- TNIP Carbon Counter assigns a single total number of seats for each aircraft type. In practice, however, there are variations in seating configurations in individual aircraft of the same type operated by different airlines or even within the fleet of a single airline. Due to the greater number of airlines providing international services from Australia compared to domestic operators, it is expected that the difference between computed and actual scheduled passenger movements will be greater for the international sector compared to the domestic sector due to the greater variability in available seats per aircraft type.

### 13.3.3 Route comparisons with the ICAO Carbon Calculator

Table 3 compares the average fuel consumed per flight (departure only) computed using TNIP Carbon Counter and the ICAO Carbon Calculator for ten city pairs. These routes were Australia's top ten international city pairs in terms of carbon emissions produced in 2008-09. In order to account for the mix of aircraft types operating on a particular route, the average fuel consumed per flight was calculated by dividing the total fuel used on that route as computed by TNIP Carbon Counter with the total number of aircraft operations in 2008-09 for that route.

| City Pair | Average fuel use per flight (kg) | | Difference (%) |
|---|---|---|---|
| | TNIP 2008-09 | ICAO Carbon Calculator | |
| Sydney-San Francisco | 139,407 | 141,622 | -1.6 |
| Sydney-Los Angeles | 134,393 | 142,539 | -5.7 |
| Sydney-Bangkok | 69,854 | 77,125 | -9.4 |
| Sydney-Singapore | 60,375 | 63,327 | -4.7 |
| Sydney-Shanghai | 60,304 | 55,196 | 9.3 |
| Melbourne-Hong Kong | 59,546 | 61,003 | -2.4 |
| Melbourne-Singapore | 56,894 | 55,564 | 2.4 |
| Sydney-Hong Kong | 56,703 | 56,668 | 0.1 |
| Brisbane-Singapore | 47,200 | 47,244 | -0.1 |
| Sydney-Auckland | 12,619 | 12,767 | -1.2 |

**Table 3: Comparisons of average fuel consumed per flight on ten international routes**

It can be seen that for 7 of the 10 routes examined the difference between the TNIP Carbon Counter and ICAO Carbon Calculator results is less than 5%.

# Appendix

## Expanded EMEP/CORINAIR Aircraft Fuel Burn Profiles

| | TNIP Carbon Counter - Aircraft Fuel Consumption for Various Flight Distances (kg) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance (nm) | 125 | 250 | 500 | 750 | 1000 | 1500 | 2000 | 2500 | 3000 | 3500 | 4000 | 4500 | 5000 | 5500 | 6000 | 14000 |
| A310 | 2,810.56 | 3,899.47 | 5,990.37 | 8,081.27 | 10,172.16 | 14,532.58 | 18,981.64 | 23,699.35 | 28,675.28 | 33,763.82 | | | | | | |
| A320 | 1,644.39 | 2,497.29 | 3,660.61 | 4,705.01 | 6,027.23 | 8,332.01 | 10,865.90 | 13,441.26 | | | | | | | | |
| A330 | 4,093.66 | 5,862.43 | 8,615.45 | 11,359.97 | 14,121.50 | 19,790.45 | 25,634.21 | 31,714.79 | 38,043.52 | 44,311.94 | 51,005.69 | | | | | |
| A340 | 3,832.91 | 5,669.09 | 8,482.38 | 11,310.86 | 14,201.21 | 20,133.18 | 26,279.80 | 32,695.54 | 39,114.82 | 45,873.85 | 52,895.18 | 60,079.36 | 67,669.69 | 75,568.29 | 83,691.99 | |
| A380 | 5,697.77 | 8,152.43 | 12,064.10 | 15,975.77 | 19,887.44 | 27,829.41 | 36,240.00 | 44,532.20 | 53,619.19 | 62,899.45 | 72,710.32 | 82,787.85 | 93,250.26 | 103,997.72 | 115,353.73 | 273,815.93 |
| Antonov 26 | 351.60 | 567.30 | 998.60 | 1,429.70 | 1,860.70 | 2,721.80 | 3,581.30 | | | | | | | | | |
| ATR 42-320 | 333.60 | 528.90 | 919.30 | 1,309.60 | 1,699.80 | 2,479.60 | 3,258.10 | | | | | | | | | |
| ATR 72-200 | 351.60 | 567.30 | 998.60 | 1,429.70 | 1,860.70 | 2,721.80 | 3,581.30 | 4,438.20 | | | | | | | | |
| B727 | 2,716.78 | 3,754.67 | 5,660.16 | 7,493.22 | 9,471.16 | 13,544.24 | 17,872.26 | 22,238.06 | | | | | | | | |
| B737-100 | 1,799.99 | 2,495.27 | 3,727.09 | 4,949.72 | 6,190.73 | 8,721.79 | 11,438.03 | | | | | | | | | |
| B737-300 | 1,799.99 | 2,495.27 | 3,727.09 | 4,949.72 | 6,190.73 | 8,721.79 | 11,438.03 | | | | | | | | | |
| B737-400 | 1,603.13 | 2,267.96 | 3,612.83 | 4,960.32 | 6,302.56 | 9,187.67 | 12,167.63 | | | | | | | | | |
| B737-700 | 1,282.50 | 1,814.37 | 2,890.26 | 3,968.26 | 5,042.05 | 7,350.14 | 9,734.10 | 11,875.25 | 14,298.45 | 16,773.19 | 19,389.42 | 22,076.76 | 24,866.74 | 27,732.72 | 30,760.99 | 73,017.58 |
| B737-800 | 1,282.50 | 1,814.37 | 2,890.26 | 3,968.26 | 5,042.05 | 7,350.14 | 9,734.10 | 11,875.25 | 14,298.45 | 16,773.19 | 19,389.42 | 22,076.76 | 24,866.74 | 27,732.72 | 30,760.99 | 73,017.58 |
| B747-100 | 6,564.83 | 9,419.78 | 14,308.04 | 19,196.29 | 24,084.55 | 34,170.53 | 44,418.98 | 55,255.17 | 66,562.31 | 77,909.24 | 90,362.10 | 103,265.90 | 116,703.31 | 130,411.02 | | |
| B747-200 | 6,564.83 | 9,419.78 | 14,308.04 | 19,196.29 | 24,084.55 | 34,170.53 | 44,418.98 | 55,255.17 | 66,562.31 | 77,909.24 | 90,362.10 | 103,265.90 | 116,703.31 | 130,411.02 | | |
| B747-300 | 6,564.83 | 9,419.78 | 14,308.04 | 19,196.29 | 24,084.55 | 34,170.53 | 44,418.98 | 55,255.17 | 66,562.31 | 77,909.24 | 90,362.10 | 103,265.90 | 116,703.31 | 130,411.02 | | |
| B747-400 | 6,330.86 | 9,058.26 | 13,404.56 | 17,750.86 | 22,097.16 | 30,921.57 | 40,266.67 | 49,480.22 | 59,576.88 | 69,888.28 | 80,789.24 | 91,986.50 | 103,611.40 | 115,553.02 | 128,170.81 | 304,239.92 |
| B757 | 2,422.90 | 3,410.18 | 5,070.35 | 6,724.43 | 8,390.71 | 11,845.75 | 15,407.03 | 19,025.89 | | | | | | | | |
| B767-300ER | 3,030.31 | 4,305.22 | 6,485.18 | 8,665.13 | 10,845.09 | 15,408.59 | 20,086.57 | 24,804.39 | 29,909.40 | 35,239.06 | 40,630.93 | 46,313.67 | 52,208.00 | | | |
| B777-200 | 4,819.58 | 7,035.14 | 10,130.36 | 13,226.45 | 16,363.80 | 22,576.41 | 29,225.68 | 36,026.67 | 43,143.25 | 50,294.63 | 57,904.29 | 65,763.50 | 73,655.15 | 82,067.40 | 90,693.23 | |
| B777-300 | 4,819.58 | 7,035.14 | 10,130.36 | 13,226.45 | 16,363.80 | 22,576.41 | 29,225.68 | 36,026.67 | 43,143.25 | 50,294.63 | 57,904.29 | 65,763.50 | 73,655.15 | 82,067.40 | 90,693.23 | |
| BAC1-11 | 1,393.85 | 2,082.41 | 3,110.10 | 4,194.78 | 5,279.46 | 7,641.62 | 10,160.03 | | | | | | | | | |
| Bae Jetstream 31 | 333.60 | 528.90 | 919.30 | 1,309.60 | 1,699.80 | | | | | | | | | | | |
| Bae Jetstream 41 | 351.60 | 567.30 | 998.60 | 1,429.70 | 1,860.70 | | | | | | | | | | | |
| BAe146 | 1,245.09 | 1,860.53 | 3,124.55 | 4,374.54 | 5,652.57 | 8,270.11 | | | | | | | | | | |
| Beech 1900C Air | 186.00 | 296.40 | 517.40 | 738.80 | 960.60 | 1,406.30 | 1,856.00 | | | | | | | | | |
| Beech Super King Air 200B | 150.50 | 241.30 | 423.00 | 604.90 | 787.10 | 1,152.60 | | | | | | | | | | |
| Beech Super King Air 350 | 167.00 | 269.40 | 474.20 | 679.20 | 884.30 | 1,294.80 | 1,706.10 | | | | | | | | | |
| Cessna 208 Cara | 92.50 | 163.90 | 306.80 | 449.70 | 592.60 | 887.90 | 1,174.90 | | | | | | | | | |
| CRJ200-LR | 665.00 | 961.20 | 1,513.60 | 2,073.83 | 2,643.10 | 3,807.00 | 5,014.60 | | | | | | | | | |
| CRJ700-ER | 929.00 | 1,323.60 | 2,021.70 | 2,736.53 | 3,482.70 | 5,062.95 | 6,682.00 | | | | | | | | | |
| CRJ900-EPP-LR | 1,022.90 | 1,444.20 | 2,206.30 | 3,007.80 | 3,824.20 | 5,485.80 | 7,201.20 | | | | | | | | | |
| Dash 8 Q400 | 625.20 | 1,006.60 | 1,769.60 | 2,532.68 | 3,295.70 | 4,821.75 | 6,348.20 | | | | | | | | | |
| DC10 | 4,727.67 | 6,804.37 | 10,487.46 | 14,170.55 | 17,853.63 | 25,476.23 | 33,218.58 | 41,492.33 | 50,361.34 | 59,452.39 | 69,037.90 | 79,034.06 | 89,397.99 | | | |
| DC9 | 1,743.86 | 2,477.97 | 3,815.30 | 5,067.12 | 6,489.97 | 9,354.91 | 12,353.90 | | | | | | | | | |
| De Hav Dash 7 | 385.30 | 629.90 | 1,119.30 | 1,608.60 | 2,097.80 | 3,075.80 | | | | | | | | | | |
| De Hav DHC-3 Turbo Otter | 100.70 | 173.40 | 318.80 | 464.10 | 609.40 | 899.60 | | | | | | | | | | |
| Dornier 328-110 | 308.10 | 480.20 | 824.40 | 1,168.60 | 1,512.80 | 2,201.40 | | | | | | | | | | |

Continued on the next page.

| | TNIP Carbon Counter - Aircraft Fuel Consumption for Various Flight Distances (kg) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance (nm) | 125 | 250 | 500 | 750 | 1000 | 1500 | 2000 | 2500 | 3000 | 3500 | 4000 | 4500 | 5000 | 5500 | 6000 | 14000 |
| Embraer 110P2A | 154.20 | 273.60 | 512.10 | 750.20 | | | | | | | | | | | | |
| Embraer EMB140 | 572.56 | 879.35 | 1,422.60 | 1,985.52 | 2,561.00 | 3,751.37 | | | | | | | | | | |
| Embraer ERJ170 | 775.24 | 1,201.12 | 1,962.02 | 2,728.27 | 3,513.90 | 5,164.07 | 6,863.00 | | | | | | | | | |
| Embraer ERJ190 | 959.77 | 1,496.48 | 2,429.10 | 3,373.64 | 4,328.37 | 6,340.90 | 8,438.00 | | | | | | | | | |
| F100 | 1,467.59 | 2,078.75 | 3,212.39 | 4,285.75 | 5,479.66 | 7,796.27 | | | | | | | | | | |
| F28 | 1,357.45 | 1,889.25 | 2,984.46 | 3,985.73 | 5,174.88 | 7,318.91 | | | | | | | | | | |
| Fokker 50 Srs 1 | 427.80 | 681.60 | 1,189.50 | 1,697.90 | 2,206.80 | 3,226.30 | | | | | | | | | | |
| Fokker F27 | 374.60 | 606.80 | 1,070.80 | 1,534.40 | 1,997.60 | 2,921.80 | 3,841.50 | | | | | | | | | |
| Lockheed C-130H | 1,101.00 | 1,960.70 | 3,680.50 | 5,400.60 | 7,121.00 | 10,563.00 | 14,006.60 | 17,452.20 | 20,900.20 | 24,351.00 | 27,805.30 | | | | | |
| Lockheed P-3B O | 943.70 | 1,598.40 | 2,907.80 | 4,217.10 | 5,526.40 | 8,144.40 | 10,761.10 | 13,375.10 | 15,982.30 | 18,570.50 | 21,061.40 | | | | | |
| MD81-88 | 2,102.90 | 3,110.99 | 4,563.92 | 5,913.09 | 7,469.77 | 10,523.32 | 13,738.70 | | | | | | | | | |
| Reims F406 Cara | 113.40 | 186.30 | 332.10 | 477.90 | 623.60 | 914.40 | | | | | | | | | | |
| Saab 2000 | 476.10 | 814.10 | 1,490.10 | 2,166.20 | 2,842.30 | 4,194.50 | | | | | | | | | | |
| Saab 340B | 259.60 | 428.90 | 767.80 | 1,107.30 | 1,447.40 | 2,130.50 | | | | | | | | | | |
| Shorts 330 | 247.90 | 408.50 | 730.00 | 1,051.60 | 1,373.40 | | | | | | | | | | | |
| Shorts 360-300 | 285.00 | 465.30 | 826.10 | 1,187.00 | 1,548.30 | | | | | | | | | | | |
| Shorts SC.7 Srs3M-200 | 188.00 | 361.50 | 706.50 | 1,048.20 | 1,385.40 | | | | | | | | | | | |
| Swearingen Metro III | 147.20 | 246.10 | 444.00 | 641.90 | 839.80 | | | | | | | | | | | |

- **Notes:** The original CORINAIR dataset has been expanded to include fuel burn profiles for the A380 and later generation B737 aircraft. The A380 has been assumed to have the same fuel burn profile as the B777. The fuel consumption for both the B737-700 and B737-800 has been set to 75% of the fuel consumption for the B737-400 (i.e. 25% more efficient) up to the range of the B737-400 (2000 nm) and 22.5% of the fuel consumption of the B747-400 for distances exceeding 2000 nm.

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